

M.O. 300.

AIR MINISTRY

METEOROLOGICAL OFFICE

INTERNATIONAL METEOROLOGICAL ORGANIZATION

COMMISSION

FOR THE EXPLORATION OF

THE UPPER AIR

REPORT OF THE
MEETING IN LEIPZIG

August 29—September 3, 1927

Published by the Authority of the Meteorological Committee.



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LIST OF INTERNATIONAL METEOROLOGICAL MEETINGS

- Congresses of Official Delegates.** Vienna 1873, Rome 1879.
- Conferences.** Leipzig 1872, Munich 1891, Paris 1896, Innsbruck 1905, Paris 1919, Utrecht 1923.
- Permanent Meteorological Committee.** Utrecht 1874, London 1876, Utrecht, 1878.
- International Meteorological Committee.** Bern 1880, Copenhagen 1882, Paris 1885, Zürich 1888, Upsala 1894, St. Petersburg 1899, (Paris 1900), Southport 1903, Paris 1907, Berlin 1910, Rome 1913, (London 1919), London 1921, Utrecht 1923, Vienna 1926.
- Commissions.**
- Terrestrial Magnetism and Atmospheric Electricity.** *Appointed* 1891. Munich 1891, Paris 1896, Bristol 1898, Paris 1900, Innsbruck 1905, Berlin 1910, Utrecht 1923, Zürich 1926.
- Exploration of the Upper Air** (formerly Scientific Aeronautics). *Appointed* 1896. Strasbourg 1898, Paris 1900, Berlin 1902, St. Petersburg 1904, Milan 1906, Monaco 1909, Vienna 1912, Bergen 1921, Utrecht 1923, London 1925, Leipzig 1927.
- Solar Radiation** (formerly **Radiation**). *Appointed* 1896, *reconstituted* 1910. Rapperswil 1912. *Reconstituted* 1919, Utrecht 1923, Davos 1925.
- Solar.** *Appointed* 1903. Cambridge 1904, Innsbruck 1905, London 1909 (not re-appointed at Paris 1919).
- Synoptic Weather Information** (formerly **Weather Telegraphy**). *Appointed* 1907. London 1909 and 1912, (Paris 1919), London 1920 and 1921, Utrecht 1923, Zürich 1926.
- Maritime Meteorology** (and Storm Warnings). *Appointed* 1907. London 1909 and 1912, (Paris 1919), London 1921, Utrecht 1923, Zürich 1926.
- Réseau Mondial.** *Appointed* 1907. Monaco 1909, London 1921, Zürich 1926.
- Polar.** *Appointed* Rome 1913. Copenhagen 1914. *Reconstituted* 1919. Bergen and London 1921 united with the Commission for the Réseau Mondial.
- Agricultural Meteorology.** *Appointed* 1913. *Reconstituted* 1919. Utrecht 1923, Zürich 1926.
- Investigation of the Sound of Explosions.** *Appointed* 1921. Innsbruck 1926.
- Application of Meteorology to Aerial Navigation.** *Appointed* 1919. (Paris 1919), London 1921.
- The Study of Clouds.** *Appointed* 1921. Utrecht 1923, Paris and Zürich 1926.
- Formation of an International Bureau.** *Appointed* 1923. Paris and Zürich 1926.

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LIST OF DELEGATES ATTENDING THE MEETING.

- Prof. Dr. E. Alt, Direktor der Sächsischen Landeswetterwarte, Dresden.
 Dr. H. Arctowski, Director of the Geophysical Institute, University of Lwow, Poland.
 Prof. V. Bjerknes, Physical Institute of the University, Oslo, Norway.
 Dr. H. G. Cannegieter, Koninklijk Nederlandsch Meteorologisch Instituut, de Bilt, Holland.
 Dr. D. la Cour, Director, Det Danske Meteorologiske Institut, Copenhagen, Denmark.
 Prof. F. Eredia, Il Capo, Ufficio Presagi, Ministero dell'Aeronautica, via del Caravita 7, Rome, Italy.
 Prof. Dr. E. van Everdingen, Director, Koninklijk Nederlandsch Meteorologisch Instituut, de Bilt, Holland.
 Prof. Dr. F. M. Exner, Direktor der Centralanstalt für Meteorologie und Geodynamik, Hohe Warte 38, Wien XIX, Austria.
 Dr. E. Fontseré, Jefe, Servei Meteorologic da Catalunya, Urgell 187, Barcelona, Spain.
 Prof. Dr. H. Hergesell, Direktor des Preussischen Aeronautischen Observatoriums, Lindenberg, Kreis Beeskow, Germany. (*President elected at the meeting.*)
 Dr. Th. Hesselberg, Director, Det Norske Meteorologiske Institutt, Oslo, Norway. (*Secretary.*)
 Dr. K. Keil, Preussisches Aeronautisches Observatorium, Lindenberg, Kreis Beeskow, Germany.
 Dr. H. H. Kimball, U.S. Weather Bureau, Washington D.C., U.S.A.
 Mr. R. G. K. Lempfert, Meteorological Office, Air Ministry, London, W.C.2. (*Secretary.*)
 Prof. Dr. F. Linke, Direktor, Meteorologisch-Geophysikalisches Institut der Universität, Frankfurt a/Main, Germany.
 Dr. G. Marczell, in charge of aerological work, M. Kir. Orszagos Meteorologiai es Foldmagnessegizet, Budapest, Hungary.
 Dr. E. G. Mariolopoulos, Chief of the Meteorological Section, Observatoire National, Athens, Greece.
 Col. E. Meseguer, Jefe, Servicio Meteorologico Español, Madrid, Spain.
 Prof. P. Moltehanoff, Director, Aerological Observatory, Slutzk (Pavlovsk), U.S.S.R.
 Dr. W. Oishi, Director, Aerological Observatory, Tateno, Ibaraki ken, Japan.
 Prof. Dr. A. Peppler, Direktor der Badischen Landeswetterwarte, Karlsruhe, Germany.
 Dr. L. F. Richardson, Westminster Training College, Horseferry Road, London, S.W.1.
 Prof. Dr. S. Róna, Director, M. Kir. Orszagos Meteorologiai es Foldmagnessegizet, Budapest, Hungary.
 Mons. Ph. Schereschewsky, 11 Eisenbahnstrasse, Sarrebruck, Sarre.
 Prof. Dr. A. Schmauss, Direktor der Bayerischen Landeswetterwarte, München, Germany.
 Sir Napier Shaw, 10, Moreton Gardens, London, S.W.5. (*President until the close of the meeting*) *Honorary President.*
 Sir Gilbert Walker, Professor of Meteorology, Imperial College of Science and Technology, South Kensington, London, S.W.7.
 Dr. A. Wallén, Director, Statens Meteorologisk-Hydrografiska Anstalt, Stockholm, Sweden.
 Mons. le Capitaine P. Wehrlé, Office National Météorologique, rue de l'Université, 176, Paris, France.
 Prof. Dr. L. Weickmann, Direktor des Geophysikalischen Instituts der Universität, Talstr. 38, Leipzig, Germany.
 Dr. P. Zistler, Bayerische Landeswetterwarte, München, Germany.

INTERNATIONAL METEOROLOGICAL ORGANIZATION

COMMISSION FOR THE EXPLORATION OF
THE UPPER AIR

MEETING IN LEIPZIG, AUGUST 29TH—SEPTEMBER 3rd, 1927.

REPORT OF THE BUREAU FOR THE PERIOD APRIL,
1925 TO AUGUST, 1927.Issued as *Circular 37* on July 14th, 1927.

1. **Report of the last meeting.**—A report of the proceedings at the meeting in London, April 16th–22nd, 1925, prepared by the Bureau of the Commission, was printed at the end of the year 1925 by H.M. Stationery Office, and issued by the Meteorological Office, Air Ministry, as an official publication M.O.281.

2. **Membership of the Commission.**—Since the meeting information has been received of the lamentable death of Professor A. Friedmann, who had shown remarkable activity during his short tenure of the direction of the Central Geophysical Observatory, Leningrad.

In July, 1925, Ernst. G. Calwagen, an enthusiastic member of the Norwegian school of meteorologists and Director of the Bergen Observatory, lost his life in the crash of an aeroplane while making a flight for the purpose of meteorological observation at Kjeller, near Oslo.

M. Fernand Jacobs, astronomer and meteorologist, founder and president of the Aeroclub of Belgium and vice-president of the International Aeronautical Federation, died in November, 1926.

More recently the Commission has suffered another most serious loss in the death on January 13th, 1927, of Dr. A. de Quervain, whose name is associated with the international co-operation in the exploration of the upper air, not only by the modification of the theodolite, which is now in common use, but by evidences of the many features of his lively imagination and scientific enthusiasm.

The names of Alexander McAdie, Professor of Meteorology in Harvard College and Director of the Blue Hill Observatory; of Major José Agostinho, Director of the Meteorological Service of the Azores in succession to the much lamented Colonel Chaves;

and of Captain J. Machado do Barros, of the Portuguese Air Service, have been added to the list of members.

Mons. Mario da Costa França and Mons. A. Moreira de Carvalho withdrew from the Commission on leaving the Portuguese Air Service. Mr. J. H. Field has resigned his position as a member of the Commission and also deputy-president for Region D (India and the Far East) upon his retirement from the Direction of the Meteorological Service of India.

The following new members will be proposed :—Dr. L. Weickmann, Director of the Geophysical Institute of Leipzig ; Dr. P. Zistler, in charge of upper air work at München ; Dr. C. W. B. Normand, Director-General of Indian Observatories ; Rev. Father L. Rodés, Director of the Observatorio del Ebro, Tortosa ; M. Henry Arctowski, Director of the Observatory at Lwow, who has intimated the co-operation of his Institute on international days by aeroplane observations ; Mr. H. A. Hunt, Director of the Commonwealth Meteorological Bureau, Australia ; Dr. E. Kidson, Director of the Dominion Meteorological Office, New Zealand ; Mr. C. Stewart, Chief Meteorologist of the Union of South Africa ; Mr. Andrew Thomson, Director of the Apia Observatory, Samoa ; Mr. T. F. Claxton, Director of the Royal Observatory, Hong Kong ; Dr. W. Oishi, Director of the Aerological Observatory at Tateno, Ibaraki-ken, Japan.

The services which contribute data and are not yet represented on the Commission are : Bulgaria, Esthonia, Iceland, Roumania, Switzerland and Ceylon.

A new president will be required in the place of Sir Napier Shaw, and a new deputy-president for Region D in the place of Mr. Field. So far, the deputy-presidents, who were appointed by Resolution XV of the London Meeting, have not had much opportunity of displaying the advantage of the arrangement. It is obviously necessary that agreement should first be arrived at as to common forms of reports of observations and of publication for the whole world ; and that could not be reached without some preliminary trial. It would have been a great relief to the Central Bureau if the work for America and for India, the Philippines and Japan, could have been carried on concurrently with that in London for Europe, with which was associated also that for South America, Africa and Australasia. Meanwhile valuable work has been contributed by all the regions enumerated in Resolution XV.

The attention of the Commission will be drawn to a resolution of the International Meteorological Committee on the subject of the discontinuance of membership of Commissions of those who take no active part in its proceedings. The question was referred to the Committee by the Commission in 1925. By the Règlement de l'Organisation Météorologique Internationale, 1919 : "Une fois constituées les Commissions ont la faculté de se compléter elles-mêmes ; elles organisent leurs travaux à leur gré." The Commission will accordingly be asked to take the resolution of the

International Committee into consideration. The resolution has been circulated together with four other resolutions of the International Meteorological Committee which have been communicated by the President of the Committee, and will be brought before the Commission in due course.

RESOLUTIONS OF THE LONDON MEETING

Nineteen resolutions were adopted at the London Meeting. The report of the action of the Bureau with regard to them is as follows :

3. Oscillations of pilot balloons.—Resolution II. No report has reached the Bureau of observations recommended by the Commission in relation to the oscillations observed by Dr. Fontseré.

4. Specimen volume of international observations of the upper air for 1923/24.—(Resolutions III, IV, V, VI, XI, XVI, XIX). The seven resolutions which are here enumerated together with Resolution XV concerning regions, which has already been referred to, and two conclusions noted in the minutes, one of provisional approval of certain forms of publication, and the other prescribing the units to be employed in international tables, constitute the règlement for the Bureau in the preparation of the specimen volume. The Bureau has the honour to present the result of its endeavour to discharge that duty in a publication entitled *Comptes rendus des jours internationaux*, 1923. The volume consists of four parts, namely :—

- I. Avant-Propos : liste des stations et leurs co-ordonnées géographiques, pp. 1–28.
- II. Cartes synoptiques avec les listes des données, manuscrites et publiées, de chaque jour, pp. 29–68.
- III. Tableaux internationaux des sondages réussis, pp. 69–176.
- IV. Folio des téphigrammes des sondages par ballon-sonde, pp. 177–196.

In the *Avant-Propos*, a general explanation is given of the basis of the *Comptes-rendus* and of the forms which were prepared as a preliminary to the work upon them. An effort was made to have this section ready for the meeting of the International Meteorological Committee in Vienna in September, 1926. Advance proofs were obtained specially for that purpose. Twenty copies were made up into a parcel with a corresponding number of copies of a report of the proceedings of the Commission for presentation to the Meteorological Committee and were despatched to the *Centralanstalt für Meteorologie und Geodynamik, Wien*, on 18th September, 1926. To the chagrin of the Bureau in November, the parcel was returned from Vienna marked "*Abgereist*."

The Commission will understand from the perusal of the work that on the one hand the endeavour to satisfy the requirements of the *règlement* was an arduous task ; and even now may be regarded as not having fulfilled all the requirements which

are included in the *règlement*; and on the other hand the efforts frankly to meet the wishes of the Commission have not been unproductive in services to the science of meteorology, quite independent of the immediate requirements of an international publication. The science is in fact in a different position for understanding the thermodynamics of the processes of weather than it was in 1921.

On behalf of the President, Mr. R. G. K. Lempfert, in a paper entitled "The most recent forms of thermodynamic indicator-diagrams for the free atmosphere" will exhibit to the meeting the latest development of the use of diagrams which have been employed for the representation of ascents. Sir Napier Shaw will give a short paper "On the cult of the inversion as a meteorological element."

The fundamental purpose of the publication is to enable the Commission to make a recommendation to the meteorological services of the world as to the question of the publication of the scientific results of the international co-operation for the exploration of the upper air. The publication now presented attempts to give what was possible in the way of co-ordinated results for the whole world. It should, however, be understood that the year 1923, which was chosen by the meeting in 1925, supplies only a small number of observations compared with that which we may suppose the compilers to have for a corresponding volume of 1928, still less compared with that which will represent the world's knowledge of the upper air in 1933. The international co-operation for the exploration of the upper air can hardly be content with the limitations which are apparent in the collection now presented. The expansion of the tables to include additional observations is, however, a matter of far less difficulty than the development of the original plan.

It would give the Bureau much pleasure to learn that the publication of a *réseau mondial* for observations at land-stations with which two of the members of the present Bureau were personally concerned, from the inception of the idea in 1910, to the regular publication which began in 1915, was supplemented, after an interval of twelve years, which covered a world-war, and the distress incidental to such a catastrophe, by a corresponding volume of observations of the upper air.

5. Distribution of the forms for the tables and of the specimen volume of *Comptes rendus*.—Since the meeting in London in 1925, ten circulars have been issued. They are numbered 27 to 36, and are mainly concerned with the notifications of the resolutions of the London meeting, of international days, and quarterly lists of data received. With Circular No. 30, dated 29th March, 1926, the Bureau issued to members of the Commission and directors of services, specimens of the forms numbered 3638, 3639, 3640, which it had prepared, together with forms B and C for thermodynamic diagrams. In response, they have received applications for forms which bring the total issue up to 1534

of *Tableau 1* (Form 3638), 814 of *Tableau 2* (Form 3639), 2765 of *Tableau 3* (Form 3640), and 1831 of Form B and 1134 of Form C. These have been supplied partly free of cost and partly on repayment. Upon the exhaustion of the stock, further supplies have been obtained.

The Bureau is of opinion that after the first distribution of specimen forms, the forms might be supplied on repayment and they have accordingly fixed provisionally the following prices:—

Forms 3638, 3639, 3640, 12·5 shillings per 100.

Form B, 15 shillings per 100.

Form C, 17 shillings per 100.

Of 500 copies of the *Avant-Propos*, 225 copies were handed to the Meteorological Office on 24th March, 1927, for circulation to members of the Commission and directors of services. The *Avant-Propos* contained the tables necessary for converting heights expressed in metres into geodynamic metres. These were reprinted, by permission, from Vol. 1 of "Dynamic Meteorology and Hydrography" by V. Bjerknes and others. In view of probable requirements, 500 additional copies of the tables were printed and have been placed on sale at 6d. each.

With regard to the distribution of copies of the other three parts of the specimen volume of *Comptes rendus*, the Bureau has up to the present confined the free issue to members of the Commission and those who have contributed data for the volume; but it contemplates the issue of a presentation copy to each of the directors of meteorological services on the list of the International Meteorological Organization. This will make a circulation of about 150.

The Bureau notes that at the meeting of the International Meteorological Committee in London in 1921 inquiry was made as to the number of copies of an international publication which might be required by the several countries represented at the meeting, and the following numbers are recorded in the report of the meeting:—Denmark 10, Great Britain 75, Holland 20, Japan 80, Norway 15, Sweden 20, making a total of 220 for the six countries named.

The Bureau will ask the Commission for instruction as to further procedure on the question of the distribution of copies. Provisionally it has ordered 500 copies of each part and has fixed a selling price for each, namely, 2·5 shillings for Part I (*Avant-Propos*), 12·5 shillings for Part II (*Cartes Synoptiques*), 15 shillings for Part III (*Tableaux*), and 10 shillings for Part IV (*Téphigrammes*).

In order that correspondence relating to the supply of copies of forms and publications might be carried on without confusion the Bureau applied to the Royal Meteorological Society for permission to keep a letter-box at the Society's House, 49, Cromwell Road, London, S.W.7, for the Secretary of the Commission. The Society very kindly agreed to do so.

6. **Preliminary circulation of the results of soundings of the upper air.**—The Bureau was directed to consult with Dr. Simpson and to arrange for a scheme of preliminary circulation of the results of soundings. Such a scheme requires common forms; two common forms come under consideration, one suitable for the results of a single ascent and the other for a co-ordinated table to include a number of ascents. The suggestion is that the contributing institutes should forward 200 copies to be collected in the Meteorological Office in London and distributed from there to the various institutes of the world.

Specimens of the forms of each kind used in the preparation of the specimen volume have been passed to Dr. Simpson, who has the matter under his consideration.

In the course of preparation of the volume a request from Dr. Thorkelsson, of Reykjavik, for data from North America for seven days in the international month of May, 1926, was met by a typewritten copy of the data arranged in the standard form.

7. **Finance.**—A statement of account for the period April 1st, 1925 to July 31st, 1927, was appended to this report and as completed up to October 31st, 1927, is printed as Appendix I, p. 68. Towards the cost of preparing and printing the specimen volume a contribution of £500 was made in advance by the Meteorological Section of the *Union Géodésique et Géophysique Internationale* at the meeting held at Madrid in October, 1924; and, by a resolution of the Commission at the meeting in London, the President was authorized to open a banking account and to receive subscriptions towards the cost of the work. To that account a sum of 1,000 gulden was paid on behalf of the Meteorological Institute of the Netherlands in 1925, and further sums of 500 gulden have been paid annually since that date. Immediately after the meeting in London a contribution of 500 gold marks was paid into the account by the Director of the Prussian Aeronautical Observatory at Lindenberg, and more recently a sum equivalent to 100 U.S. dollars has been contributed by the Central Geophysical Observatory at Leningrad.

In the opinion of the Bureau the contribution of the Netherlands Institutes in the years 1925 and 1926 must be regarded as intended for the conduct of the ordinary work of the Commission, and could not be accumulated with the funds devoted to the production of the specimen volume. It would be an abuse of the public-spirited generosity of the Netherlands to anticipate the wishes of the Commission on the subject. The sums available for the out-of-pocket expenses in connexion with the meeting in 1925, and the resolutions adopted at that meeting amount to £629.725.

It speedily became apparent that the cost of preparing, printing and circulating the volume would probably be in excess of the sum mentioned. The Bureau, therefore, took into consideration a suggestion to complete the preparation of the results for a quarter of the year 1923, namely, those for one day in

January, six days in February, and one day in March, to obtain estimates for printing the text, tables and illustrations, and issue that as a preliminary specimen and as a guide to the cost of the whole volume.

It was, however, found that the preparation of the work in a form upon which a printer could give a firm estimate would itself have involved a large expenditure; and to dispense with the services of a special assistant who had become familiar with the ideals aimed at, when the copy for the first quarter was ready and the negotiations for printing were being carried out, was most undesirable.

Further, it became abundantly clear that a large part of the cost of a complete year of that kind of work would have been already incurred for the first quarter (a specimen page alone of the tables cost £9.25), and the cost of four quarters could not be satisfactorily estimated by the cost of the first.

Accordingly the Bureau decided to entrust the work of printing to the Cambridge University Press, which has incomparable experience of the requirements of a scientific publication in which many languages may appear and the selection of types may carry implications which are quite undreamt of by the ordinary printer.

The first quarter, in as complete a form as possible, was sent to the printers in June, 1926, and, while negotiations were in progress, the assistants who had prepared the first quarter were instructed to complete the material for the whole year, on the ground that the publication of a complete year was the only satisfactory avenue to the solution of the question which the experiment was intended to solve.

At the time of writing the total cost is not ascertained, but the Commission may rely upon the volume being printed without trenching upon the sums which are quite properly regarded as allocated to the expenses of the Commission for work upon data subsequent to 1923.

The Bureau, however, felt justified in using part of those funds for the preparation of corresponding tables for September 4th, 1924, January 24th, 1925, and the international month of May, 1926, three occasions which were made the subject of special request by the Commission.

The data which have been received by the Commission since the meeting in 1925, and which represent the material awaiting publication are enumerated in a list of data which is appended to this report (Appendix II, pp. 70-6).

Upon the material thus submitted, the Bureau invites the Commission to decide upon the steps which they will recommend for providing an international publication of the results of the co-operation in the exploration of the upper air of the world.

A proposal on the subject by Professor Dr. Hergesell, Director of the Prussian Aeronautical Observatory of Lindenberg, has been inserted in the *Ordre du Jour*.

8. **Technique of Observations.**—Resolutions XVII and XVIII of the meeting of 1925, referred to the instruments in use in aeroplanes, and the rate of ascent of pilot balloons.

The information collected under the first resolution has been compiled by the Secretary (Appendix III, p. 76) and transmitted to M. Wehlé of the *Office National Météorologique de France*. A report on the rate of ascent of pilot balloons will be brought before the meeting by Professor Dr. Hergesell, President of the sub-commission to which the subject was entrusted.

Mr. L. H. G. Dines will contribute a short paper on the registration of humidity on the Dines meteorograph.

9. **The extension of the area of observations.**—Resolutions VII and VIII expressed the interest of the Bureau in the development of observations in the Dutch Indies and in Siberia respectively, while Resolution XIV invited assistance for the German expedition to the South Atlantic. The Commission can now congratulate the expedition on its successful voyage. The results are given in three *Berichte* of the *Gesellschaft für Erdkunde*, entitled "*Die Deutsche Atlantische Expedition auf dem Vermessungs- und Forschungsschiff 'Meteor.'*"

10. **International days.**—The scheme of selection of international days which was developed at the meeting of the Commission at Bergen in 1921 extends only to 1928. The question, therefore, of the choice of international days comes up for consideration at Leipzig.

Professor Dr. Exner, Director of the *Centralanstalt für Meteorologie und Geodynamik, Wien*, offers a proposal for the days to be selected by the President, with reference to the meteorological situation at the time (Appendix X, p. 95).

In this connexion, it is desirable to remind the Commission that the list of telegraphic addresses published as an Appendix to the report for 1925 should be carefully revised.

11. **New Proposals—Maps of the world.**—Professor E. van Everdingen, President of the International Meteorological Committee, has forwarded a suggestion by Mr. B. J. S. Cahill, of Oakland, California, that an 8-partite representation of the globe by folding leaves, which he calls "*Butterfly Maps*," should be adopted for international use.

12. **Contributions for scientific discussion.**—A number of scientific contributions have been received, the titles of which have been included in the provisional *Ordre du Jour*.

REPORT OF THE MEETINGS

OF THE

INTERNATIONAL COMMISSION FOR THE EXPLORATION OF THE UPPER AIR.

LEIPZIG, AUGUST 29TH—SEPTEMBER 3RD, 1927.

Upon the invitation of Dr. Weickmann, Professor of Geophysics in the University of Leipzig, the meetings of the Commission were held in the Geophysical Institute of the University.

FORMAL OPENING OF THE SESSION.

MONDAY, 29TH AUGUST, 1927, AT 9.30 A.M.

A formal meeting for the reception of the members of the Commission was held in the lecture-room of the Mineralogical Institute. It was attended by a number of ladies and gentlemen in addition to the members of the Commission. Among those present were Dr. Krug von Nidda und von Falkenstein, *Wirtschaftsminister von Sachsen, Vertreter auch des Ministers der Volksbildung*; Professor Dr. Steindorff, Professor of Egyptology, representing the Rector of the University; Professor Dr. Hergesell, representing the *Reichsministerium*; and the *Oberbürgermeister* of the City of Leipzig.

Upon taking the Chair, Sir Napier Shaw, President of the Commission, addressed the meeting as follows:—

"Vor fünf und fünfzig Jahren tagte in Leipzig eine Versammlung die in der internationalen Organisation des ewigen Problems des Wetters, epochemachend war.

Sie schaffte für die Praxis der meteorologischen Beobachtungen an Landstationen und für die vergleichende meteorologischen Statistik die internationalen Grundlagen, auf denen das Schema dass heute von den Meteorologischen Instituten befolgt wird, aufgebaut worden ist.

Sie erweiterte das Verfahren das neunzehn Jahre früher für die Meteorologie der Meere eingeleitet worden war, und beanspruchte das Zusammenwirken von noch mehr Ländern.

To-day, through the good offices of Dr. Weickmann, a new meeting in Leipzig begins for the purpose of extending and developing the international co-operation in the study of the upper air over both land and sea, and can claim the attention of the civilized world because the upper air, the free atmosphere, is becoming a highway, perhaps soon to be the principal highway of the nations.

The meteorologists who have been most prominent in the development of that aspect of the science must be well-known in Leipzig—Assmann, Hergesell, Teisserenc de Bort, and Rotch. The name of my own countryman, Dines, may also have found its way to this centre of intellectual and literary activity; and surely the name of de Quervain, whom we have only recently lost, will be known to this assembly.

The development of so important a study is naturally watched with interest by all those who are concerned in public economics, education and civil life generally, and it is therefore not unnatural that our opening meeting should be honoured by the presence of distinguished representatives of these aspects of human endeavour.

I will ask Herr Wirtschaftsminister, Dr. Krug von Nidda und von Falkenstein, Vertreter auch des Ministers der Volksbildung, to speak first, and afterwards our colleague, Prof. Dr. Hergesell, representing the Ministry of the German Realm, Prof. Dr. Steindorff representing the Rector of the University, and the Oberbürgermeister of this ancient and busy city.

Herr Wirtschaftsminister Dr. Krug von Nidda und von Falkenstein, Vertreter des Ministers der Volksbildung extended a welcome to the Commission in the following:

Begrüßungsansprache.

“Die sächsische Regierung hat es mit lebhafter Freude begrüßt, dass die Internationale Kommission zur Erforschung der freien Atmosphäre ihre erste nach langer Pause wieder auf deutschem Boden stattfindende Tagung nach Sachsen und an den Sitz der sächsischen Landesuniversität zu legen sich entschlossen hat. Ich heisse Sie daher hier in Vertretung des zu seinem Bedauern verhinderten Ministers für Volksbildung und zugleich in meiner Eigenschaft als Wirtschaftsminister namens der sächsischen Regierung herzlich willkommen.

Die sächsische Regierung hat es von je her als ihre besondere Ehrenpflicht angesehen, alle wissenschaftlichen Bestrebungen nach Kräften zu unterstützen und sie hat daher auch dem von Ihnen, meine Damen und Herren, vertretenen Zweig der Wissenschaft stets das lebhafteste Interesse entgegengebracht. Ich darf daran erinnern, dass die Philosophische Fakultät unserer Universität kurze Zeit nach dem das Geophysikalische Institut in Göttingen seine Tätigkeit aufgenommen hatte, den dringenden Antrag auf Errichtung eines Lehrstuhls und eines Instituts für Geophysik stellte. In dem Bericht betonte sie ausdrücklich, die Universität solle auch in dieser Beziehung mit “führen,” nicht aber später durch das Vorgehen anderer Universitäten “mitgeschleppt” werden. Das Kultusministerium griff den Plan sofort auf und es gelang ihm, Herrn Prof. Dr. Bjerknes als ersten Inhaber des Lehrstuhls und Direktor des Geophysikalischen Instituts zu gewinnen. 4 Jahre durften wir ihn als besondere Zierde der Universität den Unseren nennen und wir freuen uns herzlich, dass er anlässlich dieser Tagung wieder Einkehr an der Stätte seiner früheren Wirksamkeit gehalten hat.

Wir können Ihnen, meine Damen und Herren, leider kein glänzend eingerichtetes und mit den neuesten Instrumenten ausgestattetes Geophysikalisches Institut vorführen! Die schwere Not unseres Landes hat uns auch hier zu unserem lebhaften Leidwesen zu grossen Einschränkungen gezwungen. Aber die hohe wissenschaftliche Tradition, die mit Herrn Professor Bjerknes ihren verheissungsvollen Anfang nahm, ist trotz aller Kampf- und Notzeit die gleiche geblieben und ich darf darin, dass Sie Ihre Tagung hierher an dieses Institut verlegt haben, auch dankbar eine Anerkennung dieser Tatsache erblicken.

Neben dem Geophysikalischen Institut arbeitet, die um 50 Jahre ältere, dem Geschäftsbereich des Wirtschaftsministeriums unterstehende Landeswetterwarte auf den Gebieten Ihrer Wissenschaft.

Aber beide Institute dienen nicht nur der abstrakten Wissenschaft, sondern stehen in enger Fühlung mit dem praktischen Leben, ebenso wie ihre Bestrebungen die Aufgaben und Ziele von Theorie und Praxis umspannen und gerade den letzteren Aufgaben gilt mein besonderes Interesse.

Im Zeitalter des Luftverkehrs, der Transozeanfänge von West nach Ost, von Ost nach West, gewinnt Ihre Arbeit eine gewaltige praktische Bedeutung. Sie sind ja berufen, die Wege zu weisen durch das Luftmeer, jene weltumspannende Brücke der Völker, die keine Schranken und Grenzen kennt, es seien denn meteorologische. Die Anwendung der Ergebnisse Ihrer Forschung auf die praktische Flugberatung bereitet die Sicherheit des Verkehrs durch die Luft vor. So wie die Deutsche Seewarte und ähnliche in anderen Ländern bestehende Einrichtungen durch Sturmwarnungsdienst, durch Seekarten u. a. der Schifffahrt dienen, so ist es ja Ihre Aufgabe die Grundlagen für den Flugverkehr über Länder und Meere zu schaffen. Dieser Aufgabe gehört zweifellos ein gut Teil der wirtschaftlichen Zukunft. Das Sächsische Wirtschaftsministerium und das Sächsische Ministerium für Volksbildung haben in der Erkenntnis der Bedeutung dieser Aufgabe und der zu ihrer Lösung notwendigen Untersuchungen und Forschungen den beiden sächsischen Instituten, die sich mit dieser Frage beschäftigen, der Sächsischen Landeswetterwarte und dem Geophysikalischen Institut der Universität Leipzig die Mittel zur Verfügung gestellt zur Teilnahme an den internationalen aerologischen Aufstiegen, und es ist zu hoffen, dass diese Institute nützliche Beiträge zu den Arbeiten Ihrer Kommission liefern werden.

Es ist mein Wunsch, dass Ihre Tagung zu den vielen glänzenden Erfolgen, die Sie in der 30 jährigen Geschichte Ihrer Kommission zur Erforschung der freien Atmosphäre erringen konnten, weitere gesellen möge, und es ist mein besonderer Wunsch, dass so, wie das Element, dem Sie dienen, der freie Lufthoden keine Schranken und Grenzen der Völker kennt, auch Ihre Verhandlungen und Studien frei von solchen Schranken zum Wohle der Menschheit höchsten Zielen zugewandt, reichen Erfolg bringen mögen.”

Professor Dr. Hergesell, on behalf of the German Government, spoke as follows:—

“Meine Damen und Herren! Herr Minister! Sehr geehrte Herren Kollegen! Mir ist der ehrenvolle Auftrag zuteil geworden, Sie bei dieser Versammlung im Auftrag der Reichsbehörden zu begrüßen. Ich führe diesen Auftrag im Namen des Reiches, besonders aber derjenigen Ministerien, die speziell die Meteorologie fördern, des Reichsministeriums des Innern, des Reichsverkehrsministeriums, des Reichsministeriums für Ernährung und Landwirtschaft und des Auswärtigen Amtes freudig aus, weil zum ersten Mal nach dem Krieg eine Internationale Meteorologen-Konferenz auf deutschem Gebiet stattfindet und damit dem Brauch der Vorkriegszeit folgt, in der internationale Konferenzen in Deutschen Städten die Fundamente zu den erdumfassenden Arbeiten gelegt haben, über deren einen Teil wir in diesen Tagen beraten wollen. Die Organisation der Deutschen Meteorologie ist ja insofern besonders kompliziert, als Reich und Länder sich berufen fühlen, an der Förderung der Wissenschaft mitzuarbeiten. Die Länder haben es von alters her als ihre besondere Aufgabe empfunden, wissenschaftliche Ziele zu verfolgen und auch das Reich hat sich mehr und mehr diesen Fragen gewidmet. Sachsen hat wie Sie bereits hörten, seit langer Zeit mit zwei Instituten an der Förderung unserer Spezialwissenschaft, gewirkt mit welchem Erfolge brauche ich in diesem Kreise nicht weiter zu erörtern. Ebenso wie Sachsen haben sich auch Baden und Bayern an der Erforschung der Atmosphäre beteiligt, ebenso auch Preussen. Der Preuss. Minister für Kunst, Wissenschaft und Volksbildung hat mich daher ebenfalls beauftragt, seine besten Wünsche für den Verlauf dieser Tagung zu überbringen. Meine Damen und Herren! Der Krieg hat vieles zerstört, er hat in der Aerologie fördernd gewirkt. Aus einer, von vielen über die Schulter betrachteten Wissenschaft vom Wetter ist ein gewaltiger Bau von grösster Bedeutung auch für die Praxis entstanden. Der

Krieg zerstörte die internationale Zusammenarbeit, aber die Meteorologie kann keine Grenzen vertragen, sie braucht Einheitlichkeit, und so war es unsere Wissenschaft, die als erste wieder eine Zusammenarbeit aufnahm. Dass das ohne grosse Reibungen geschehen konnte ist das Verdienst des Präsidenten des Internationalen Meteorologischen Comitées Prof. van Everdingen, ist ebenso ein Verdienst von Sir Napier Shaw. Aufgaben, die vor dem Kriege nur auf Europa ausgedehnt wurden, einheitliche Termine und Methoden für die Erforschung der Atmosphäre zu verwenden, und die man vorsichtig bis nach Amerika zu erstrecken versuchte, sind heute auf die ganze Welt ausgedehnt. Auf dem breiten Fundament, das unsere Wissenschaft im wahren Sinne zu einer Weltwissenschaft macht, haben wir nach dem Kriege, besonders nach der Londoner Tagung, weitergebaut. Neben dem Präsidenten der internationalen Kommission für die Erforschung der freien Atmosphäre stehen heute regionale Präsidenten für die einzelnen Teile der Erdoberfläche. Ich nenne hier die 6 Bezirke: Nordamerika, Südamerika, Europa mit Russland, Sibirien und Nordafrika, Ostindien und Philippinen, Südafrika und Australien. Die Teilung geschah nicht nach politischen Grenzen sondern nach meteorologischen Gesichtspunkten. Auch Deutschland hat an der Erforschung der freien Atmosphäre der Erde in der letzten Zeit in ausgedehnterem Masse teilgenommen durch die Fahrten des Forschungsschiffes *Meteor* im Südatlantischen Ozean, auf die ich später noch zurückkommen werde.

Und so möchte ich diese Worte der Begrüssung mit dem Rückblick beenden auf die Entwicklung der Meteorologie in den letzten Jahren, von der ich eine weitere Entwicklung in der Zukunft erwarte. Ich spreche noch einmal im Namen des Reichs im herzlichen Willkommen und die besten Wünsche für eine gute, gedeihliche Arbeit aus."

Professor Dr. Steindorff, on behalf of the Rector of the University.

Sehr geehrte Damen und Herren.—Im Auftrage des leider nicht anwesenden Rektors und des Senates der Universität Leipzig habe ich die grosse Ehre, Sie in den Räumen der Universität willkommen zu heissen und unserer grossen Freude Ausdruck zu geben, dass die Internationale Kommission zur Erforschung der freien Atmosphäre ihre erste Tagung nach dem Weltkriege in Leipzig abhält. Ungeheuer gross und zahlreich sind die wissenschaftlichen Arbeiten, die heute an Sie herantreten und die die Kommission zu bewältigen hat.—Ich denke zurück an die Zeit, in der ich vor 50 Jahren auf der Schulbank gesessen und—ich muss es leider bekennen, ohne allzuviel Teilnahme—dem recht mangelhaften Physikunterricht zugehört habe. Was uns damals von der Atmosphäre beigebracht wurde, beschränkte sich im Wesentlichen darauf, dass es vier Winde gebe, und mit grosser Mühe hatten wir die griechischen Namen dieser Winde auswendig zu lernen. Ich will Ihnen übrigens auch verraten, welches meine Vaterstadt war, in der mir diese tiefe Weisheit beigebracht worden ist. Dessau, die Stadt, deren Name gegenwärtig in der gesamten gebildeten Welt genannt wird. Wenn auch das grosse Unternehmen, das dort von einem genialen Manne geplant war, in seinen Anfängen gescheitert ist, durch die Tücke der Atmosphäre, so ist der Versuch doch gewiss nicht gering zu bewerten, und es gilt auch hier das Wort: in magnis voluisse sat est.

Auf dem Wege, den die Erforschung der freien Atmosphäre und überhaupt die Meteorologie in den letzten Jahrzehnten genommen hat, ist die Universität Leipzig, wie ich mit Stolz betonen kann, ein gutes Stück mit vorwärts gegangen. Durch die Fürsorge der Sächsischen Staatsregierung wurde auf Antrag von Otto Wiener, dessen vornehme Gestalt wir am heutigen Tage mit tiefem Schmerze vermissen, das Geophysikalische Institut begründet und der Meteorologie ein neues, wissenschaftliches Arbeitsfeld eröffnet. Prof. Bjerknes wurde zu seiner

Leitung berufen, und seiner hervorragenden wissenschaftlichen Persönlichkeit ist es zu danken, dass das junge Institut vom Tage seiner Gründung an einen glänzenden Aufschwung nahm. Leider ist Prof. Bjerknes nicht lange in unserer Mitte geblieben; ihn heute an der Stelle seiner alten Wirksamkeit wiederzusehen und zu begrüßen, ist mir eine besondere Freude. Sein Nachfolger wurde der unvergessliche Wenger, den ein allzu früher Tod seiner Arbeit entriss. Ein schwerer Schicksalsschlag für das Institut. Jetzt sehen wir an der Spitze unseren Kollegen Weickmann, der hoffentlich fernen Sirenenklängen sein Ohr verschliessend, noch lange der Unruhe bleiben wird.

Ihre Wissenschaft, meine Damen und Herren, ist mehr als viele andere auf die internationale Zusammenarbeit angewiesen. Will sie gedeihlich vorwärtsschreiten, so ist dies nur durch gemeinsame Arbeit der Forscher möglich. Der verhängnisvolle Weltkrieg hat auch hier für Jahre die Bande zerrissen; jetzt sind sie wieder geknüpft, und ich darf es mit grosser Genugtuung und Dankbarkeit aussprechen, dass es Deutschland und in Deutschland wiederum Leipzig ist, wo Sie, meine Damen und Herren, zum ersten Male sich wieder zusammengefunden haben. Internationale Arbeit fördert jede Wissenschaft, nicht zum wenigsten aber eine Weltwissenschaft wie es die Meteorologie ist. Möge sie in Leipzig gedeihen und die schwere Arbeit, die Sie in dieser Woche zu leisten haben nicht nur Ihnen selbst, sondern der Wissenschaft im Allgemeinen und der Menschheit zum Segen werden. So sage ich Ihnen zum Schlusse noch einmal ein herzliches Willkommen.

Oberbürgermeister, Dr. Rothe, reiterated the welcome of the members to Leipzig, in the following words:—

Ich begrüße die Internationale Kommission zur Erforschung der freien Atmosphäre namens der Stadt Leipzig. Die Kommission ist in unserer Stadt ja nicht fremd. Schon vor 50 Jahren hat die Kommission hier getagt und Leipzig hat sogar die Ehre, die Stadt der Gründung Ihrer Kommission zu sein. Seitdem hat sich freilich viel verändert. Die Stadt ist gewachsen nach innen und nach aussen. Sie sehen sie z.Zt. im Zeichen der Messe, die jetzt alles beherrscht. Aber Leipzig ist nicht nur eine Stadt des Handels, sondern auch eine Stadt der Wissenschaft und als Oberhaupt der Stadt freue ich mich ganz besonders hier einen wissenschaftlichen Kongress in unseren Mauern willkommen zu heissen, umso mehr als er der erste Kongress Ihrer Wissenschaft ist, der nach dem Kriege auf deutschem Boden tagt.

Ich wünsche Ihren Verhandlungen reichsten Erfolg. Wenn auch die Unterbringung da und dort nicht alle Wünsche befriedigt, so hoffe ich doch, dass Sie sich wohl fühlen werden und dass Sie ausser den reichen Früchten Ihrer wissenschaftlichen Arbeit auch angenehme Erinnerungen an die Stadt Leipzig in Ihre Heimat mitnehmen werden.

In reply to the addresses of welcome, Sir Napier Shaw said:—

The Commission will, I am sure, wish me in its name to thank the gentlemen who have conveyed to us so warm a welcome. Our task is one of great interest and some difficulty; because we aim at nothing less than the penetration of the secrets of the upper air of the whole world. Our duty and our privilege is to seek a means of co-ordinating the effort of all countries, which will command the sympathy of the whole of the civilized world, and in this, as in other cases, sympathy has its financial aspect.

Our efforts in that direction are guided by the knowledge that the study of meteorology in order to achieve success, as science counts success, must be a world-study.

The scientific study of the meteorology of any single country may be regarded as a department of economics, or as a department of physics;

but it is only when the survey is extended to the whole world that meteorology becomes a science of itself.

Towards that goal we constantly strive, and will continue to strive, encouraged by the kind words which the representatives of the Saxon Government, the Reich, the University and the City have extended to us.

The special business of this meeting is the co-ordination of results in the form of a publication for which the approval and the support of the world can be asked. And it is indeed that alone which accounts for my presence here in this position. Six years ago a meeting was held at Bergen under the presidency of Prof. V. Bjerknes, a former director of the Geophysical Institute of the University of Leipzig, to consider the revival of an international publication.

The meeting was very enthusiastic and propounded many ways in which the science of the upper air could find expression, and it assessed the cost of so great an enterprise at a very modest figure. But it found the world very unwilling to face that aspect of the situation. Prof. Bjerknes, impatient, if I may so express it, of the details of administration, as we all should like to be if we could, passed on to me the duty of carrying on the attempt, because at that time I was President of the International Committee.

I made various efforts at co-ordination, without any satisfaction either for myself or for anyone else; and finally I came to the conclusion that the only course from the scientific, or from the practical, point of view, was to prepare a specimen volume in order that the world might know what it was asked to support. I managed to obtain some substantial contributions for that object; and, after the Commission had laid down the lines that we were to follow, contributions were received from the Meteorological Institute of the Netherlands, the Director of the Observatory at Lindenberg, and, more recently, from the Geophysical Observatory of Leningrad. With that support and encouragement I have discharged the task and the specimen volume is before the meeting.

It consists of four parts:—

- I. A list of stations of the world in which the study of the upper air is pursued.
- II. A series of synchronous charts of the distribution of pressure over the globe on the 36 international days of 1923; the first charts of the two hemispheres, so far as I know, which have ever been published.
- III. Tables of data of the international observations, which are certainly rather appalling in their complexity; but much less so than the data as they came to me, and
- IV. A series of diagrams of the results of soundings with registering balloons, that are peculiarly interesting as displaying the relations of the energy of saturated or unsaturated air to its environment.

When that volume is presented my duty to the Commission is discharged and the way is open for my successor.

I cannot claim that the *Wirtschaftsminister* will find in it any immediate application of meteorological knowledge to public economy, but I think I can assure the Minister of *Volksbildung* that it presents novel aspects of intellectual activity which may be of interest and importance; and the Rector of the University that it may enhance the claim of meteorology as a geophysical science worthy of this renowned university; and the *Oberbürgermeister* that the City of Leipzig will not regret the help and encouragement which the citizens of Leipzig have given in this busy time to the cultivation of the science of the upper air.

Copies of the specimen volume were placed at the disposal of the visitors and the meeting adjourned at 10 h. 45 m.

MINUTES OF PROCEEDINGS OF THE BUSINESS MEETINGS

**First Business Meeting, Monday, 29th August, 1927, at
11.10 a.m.**

Present:—Sir Napier Shaw (*President*) in the Chair, Dr. Hesselberg (*Secretary*), Mr. R. G. K. Lempfert (*Secretary*), Prof. V. Bjerknes, Dr. D. la Cour, Prof. Dr. E. van Everdingen, Prof. Dr. F. M. Exner, Dr. E. Fontseré, Prof. Dr. H. Hergesell, Dr. F. Linke, Colonel E. Meseguer, Dr. P. Moltchanoff, Dr. S. Róna, Mons. P. Schereschewsky, Dr. A. Schmauss, Sir Gilbert Walker, Dr. A. Wallén, Mons. le Capitaine Wehrlé.

The following were present by invitation:—Dr. Alt (Dresden), Dr. H. Arctowski (Lwow), Miss E. E. Austin (London), Dr. H. G. Cannegieter (de Bilt), Dr. Keil (Lindenberg), Fräulein Dr. L. Lammert (Leipzig), Dr. G. Marczell (Budapest), Dr. E. G. Mariopoloulos (Athens), Dr. W. Oishi (Tateno), Dr. A. Peppler (Karlsruhe), Prof. Dr. L. Weickmann (Leipzig), Dr. P. Zistler (München).

Circulation of documents.—The following documents were distributed:—

(1) Memorandum concerning the Variables of Dynamical Meteorology and their Units by Prof. V. Bjerknes (Appendix IV, p. 85).

(2) Letter from Colonel Gold (London) on "Geopotential at Stations" (Appendix IV, p. 87).

(3) Communications from Dr. Witkiewitch, Moscow (Appendix IX, p. 93):

(a) Selbstregistrierender Theodolit;

(b) De la hauteur maximale du ballon pilote.

(4) Summary of Papers submitted by P. A. Moltchanoff (Appendix VIII, p. 91).

Copies of the data for September 4th, 1924, January 25th, 1925, and the international month of May, 1926, which had been co-ordinated and prepared for the printer were laid upon the table, together with the files of tephigrams of ballon-sonde ascents for the same occasions.

The President also referred to the forms for the return of data, copies of which were available.

Report of the Bureau.—The report of the Bureau (*see p. 1*) which had been circulated in July was taken as read, and approved.

Correspondence.—The President reported the receipt of apologies for absence from the following:—

DR. C. F. MARVIN (United States), who had written to say that, although he was unable to be present himself, he hoped that

Dr. Kimball, who expected to arrive in Leipzig on 30th, might be allowed to attend as the representative of the Weather Bureau. Dr. Kimball would bring with him copies of a memorandum on "Items submitted by the U.S. Weather Bureau for the consideration of the International Commission for the Exploration of the Upper Air." (pp. 26, 40.)

PROFESSOR MCADIE, of Blue Hill Observatory.

MR. J. PATTERSON, of Toronto, from whose letter the following extract is quoted :—

"The May, 1926, ascents in Canada were posted to you last week and I trust that they may reach you in time for the Leipzig meeting. I am sorry that it is not possible for me to get to the meeting and I hope that it will be very successful.

It seems to me that an International publication for the Upper Air data obtained on international days is most desirable, and while I do not know what view the Canadian Government would take of it, I would be willing to recommend that they should contribute an amount equal to what it costs to publish the part contributed by Canada, or what it would cost to publish it here."

A note on units taken from the letter is printed in Appendix IV, p. 87.

DR. FUJIWARA, of Tokyo, who, though unable to come to Europe for the meetings had written to say that he hoped Japan might be represented by Dr. Oishi, Director of the Aerological Observatory at Tateno. The President welcomed Dr. Oishi to the meetings.

MR. J. H. FIELD, Deputy-President of Region D, who had written to announce his retirement from the position of Director-General of Indian Observatories, and his resignation from membership of the Commission.

MAJOR AGOSTINHO, the successor of Colonel Chaves as Director of the Meteorological Service of the Azores.

PROFESSOR PALAZZO, who had written to express his regret at the absence of the Italian members from the meeting but had suggested that Professor Eredia, who had recently been appointed Directeur du Service des Prévisions du Temps au Ministère de l'Aéronautique, should attend to represent Italy.

COL. E. GOLD, MR. W. H. DINES, MR. L. H. G. DINES, and CAPT. C. J. P. CAVE from Great Britain.

MR. L. F. RICHARDSON and SEÑOR GALBIS both hoped to arrive later in the meeting.

The President also reported the receipt of a letter from DR. BOEREMA forwarding data for the Dutch East Indies.

The President welcomed Dr. Mariolopoulos as the representative of Greece; and Dr. H. Arctowski, Professor of Geophysics and Meteorology in the University of Lwow.

New Members.—The following were proposed as new members of the Commission and their election was unanimously approved (see also p. 45).

REGION A: *United States*: Mr. W. R. Gregg, Chief of the Aerological Division of the Weather Bureau, Washington.

REGION B: *Brazil*: Dr. Sampaio Ferraz, Director of the Meteorological Service of Brazil.

REGION C: *Germany*: Prof. Dr. Alt, Direktor der Sächsischen Landeswetterwarte, Dresden; Prof. Dr. A. Peppler, Direktor der Badischen Landeswetterwarte, Karlsruhe; Prof. Dr. L. Weickmann, Direktor des Geophysikalischen Instituts der Universität, Leipzig; Dr. P. Zistler in charge of aerological work at München.

Greece: Dr. E. G. Mariolopoulos, Chief of the Meteorological Section of the National Observatory of Athens.

Holland: Dr. H. G. Cannegieter, of de Bilt.

Hungary: Dr. G. Marczell, in charge of the aerological work at Budapest.

Italy: Prof. F. Eredia, il Capo, Ufficio Presagi, Ministero dell'Aeronautica.

Poland: Dr. H. Arctowski, Director of the Geophysical Institut, University of Lwow.

Spain: Rev. Father Rodés, Director of the Observatorio del Ebro, Tortosa.

REGION D: *British India*: Dr. C. W. B. Normand, who recently succeeded Mr. J. H. Field as Director-General of Indian Observatories.

Hong Kong: Mr. T. F. Claxton, Director of the Observatory.

Dutch East Indies: Dr. J. Boerema, Director of the Royal Magnetic and Meteorological Observatory at Batavia.

REGION E: *South Africa*: Mr. C. Stewart, Chief Meteorologist, Pretoria.

REGION F: *Australia*: Mr. H. A. Hunt, Commonwealth Meteorologist, Melbourne.

New Zealand: Dr. E. Kidson, Director of the Meteorological Service of New Zealand.

Samoa: Mr. Andrew Thomson, Director of the Observatory of Apia.

REGION J: *Japan*: Dr. W. Oishi, Director of the Aerological Observatory, Tateno, Ibaraki ken.

Ordre du Jour.—The *Ordre du Jour* was approved as follows :—

Monday, August 29th, 09h.30m. to 12h.30m. (Business meeting).

Appointment of new members.

Report of the Bureau.

Consideration of the specimen volume, and of the forms (Tableaux 1, 2, 3) and the graphs (B, C, D, E).

Mr. Cahill's "Butterfly maps."

14h.30m. to 16h.30m. (Scientific meeting).

Mr. R. G. K. Lempfert, on behalf of the President, "The most recent forms of thermodynamic indicator-diagrams for the free atmosphere."

Dr. P. Zistler, "Ueber die Windverhältnisse in der Stratosphäre ueber München."

Tuesday, August 30th, 09h.30m. to 12h.30m. (Business meeting).

Consideration of the resolutions, II, IV, XV, LXV, LXXVI, of the meeting of the International Meteorological Committee at Vienna in September, 1926. (See pp. 20-23.)

Forms and graphs of specimen volume (further discussion).

Consideration of data for September 4th, 1924; January 24th, 1925; and the international month of May, 1926.

14h.30m. to 16h.30m. (Scientific meeting).

Dr. H. Hergesell. Report of the sub-commission appointed to consider the rate of ascent of pilot-balloons and other questions connected with balloons.

Dr. E. Fontseré, "Oscillations des ballons-pilotes observées à Barcelona pendant les années, 1925, 1926, 1927 jusqu'à juillet."

Dr. P. Moltchanoff, "The rate of ascent of pilot-balloons at the altitude of 0.1, 0.5, and 1.0 km. in connection with wind-velocity."

Dr. K. Keil, "Was verlangt der Luftverkehr von der Aerologie und was bietet er für die Forschung."

Dr. P. Moltchanoff, "Instrument for the investigation of the wind in the free atmosphere and some results of its application."

Sir Napier Shaw. "The cult of the inversion as a meteorological element."

Wednesday, August 31st, 09h.30m. to 12h.30m. (Business meeting).

Finance. Receipts and Expenditure. Further consideration of specimen volume.

Proposals of Prof. Dr. Hergesell with regard to the financial arrangements. (See pp. 29-31.)

14h. 30m. Visit to Leipziger Messe.

Thursday, September 1st, 09h.30m. to 12h.30m. (Business meeting).

Discussion of geopotential and geometric height.

14h. 30m. to 16h.30m. (Scientific meeting).

Dr. P. Moltchanoff, "Apparatus for transmitting a recorder's readings at a distance."

"The prospects of development of aerology in connection with the up-to-date acquirements of aeronautics."

Mr. L. H. G. Dines, "On the humidity-trace of a Dines-meteorograph."

Dr. B. Haurwitz, "Ueber die Beziehungen zwischen Luftdruck-und Temperatur-Aenderungen in der Atmosphäre. Ein Beitrag zur Frage des 'Sitzes' der Luftdruckschwankungen."

Friday, September 2nd, 1927, 09h.30m. to 12h.30m. (Business meeting).

Election of President.

The choice of international days in continuation of Resolution 20 of the Bergen meeting, 1921, which extends to 1928.

Proposal by Dr. F. M. Exner on the days to be selected by the President (Appendix X).

14h. 30m. to 16h.30m.

Dr. Witkiewitch (a) Selbstregistrierender Theodolit.

(b) De la hauteur maximale du ballon-pilote.

Other Business.

Saturday, September 3rd, 1927, 09h.30m.

Protocol.

Specimen Volume.—The Commission proceeded to the preliminary consideration of the specimen volume of 1923; the President reported that 25 copies had been brought for use at the meeting.

The President referred to the main features of the four parts, and suggested that a small sub-commission should be appointed to consider each part. He proposed to appoint a chairman for each sub-commission, but explained that he did not wish to limit the membership of the sub-commissions.

Mr. Cahill's proposal for the "butterfly-maps" would be considered in connexion with Part II, *Cartes Synoptiques*. With reference to that part, the President drew the attention of the Commission to the difference of units employed in the maps; also to the two discontinuities of time on the east and west of the American continent. He expressed his confidence in the accuracy of the pressure maps in spite of their small scale.

In connexion with Part III, two new symbols had been invented: \square to denote observations at the surface and \triangle to denote observations of clouds.

After a brief description by the President of the diagrams of Part IV, Dr. E. van Everdingen expressed the thanks of the Commission to the President for the great work that he had accomplished in producing the specimen volume, and expressed the hope that now such a volume had become a reality, the Commission, at its present meeting, might find some means of providing for its continuation.

The President thanked Dr. E. van Everdingen and the Commission for the vote of thanks and referred to the volume as the natural continuation of the *Réseau Mondial* with which, in connexion with Mr. Lempfert, he had also been personally associated at a meeting in Berlin in 1910.

The meeting adjourned at 12.30 p.m.

NAPIER SHAW,
President.

September 3rd, 1927.

Second Business Meeting, Tuesday August 30th, 1927, at 9.30 a.m.

Present : Sir Napier Shaw (*President*) in the Chair, Director Th. Hesselberg (*Secretary*), Mr. R. G. K. Lempfert (*Secretary*), Dr. Alt, Dr. Arctowski, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. D. la Cour, Prof. F. Eredia, Prof. Dr. E. van Everdingen, Prof. Dr. F. M. Exner, Dr. E. Fontseré, Prof. Dr. H. Hergesell, Dr. Keil, Prof. Dr. Linke, Dr. G. Marzell, Dr. E. G. Mariolopoulos, Colonel E. Meseguer, Dr. P. Moltchanoff, Dr. W. Oishi, Dr. A. Peppler, Dr. S. Róna, Dr. A. Schmauss, Mons. Ph. Schereschewsky, Sir Gilbert Walker, Dr. A. Wallén, Mons. le Capitaine Wehrle, Prof. Dr. Weickmann, Dr. P. Zistler.

Exhibition of meteorological instruments.—Before the opening of the meeting, members were given the opportunity of inspecting the exhibition of meteorological instruments arranged by Wilhelm Lambrecht A. G., Göttingen, R. Fuess, Berlin-Steglitz, Askania-Werke, Berlin, and Bosch und Bosch, Hechingen.

The meeting opened at 9.50 a.m.

Documents circulated.—(a) Präsenzliste für die Geschäftssitzung, Montag den August 29 1927.

(b) "La technique des sondages par avion," which had been prepared in response to resolution XVII, of the London meeting (Appendix III, p. 76.)

Time of the scientific meetings.—The President announced that in order to leave time for meetings of sub-commissions, and for the transaction of other business, he proposed, with the approval of the members, that the afternoon-meetings on Tuesday and Thursday should be held from 15.30 to 17.30 instead of from 14.30 to 16.30.

Resolutions of the meeting of the International Meteorological Committee at Vienna.—(a) Resolution II of the Vienna meeting:—

"Le Comité recommande d'envoyer chaque mois au Président de la Commission pour l'Etude de la Haute Atmosphère, les données sur l'heure et la date de tous les sondages aérologiques, contenant des observations de température, afin que le Président puisse adresser, chaque mois, aux intéressés une liste de l'ensemble des observations aérologiques disponibles."

The President reported that in response to the resolution, lists of data had been received from Austria, Vienna (1922, 1925, 1926, 1927); Germany, Munich (February, 1927); Great Britain (1926, 1927); Hungary, Budapest (1925, 1926, 1927); Russia (February, 1927); Sweden (November, December, 1926, February March, 1927), and also a note had been received from China of ascents at Hong Kong in May, 1927.

Lists of these ascents had up to the present been included in the circulars issued by the Bureau.

Dr. Wallén submitted a "Rapport sur les travaux d'exploration de la haute atmosphère effectués en Suède depuis, 1924" (Appendix V, p. 88).

Dr. Hergesell explained that the resolution adopted by the Committee had been taken at his instigation, but the wording adopted did not entirely comply with his intentions, which were that the President should receive early intimation of all ascents actually made, irrespective of whether the ascents had been successful or not. He therefore proposed the following supplement to the resolution:—

"A côté du rapport mensuel sur les résultats des ascensions on demande d'envoyer immédiatement après la fin d'un mois au président, la liste des entreprises aérologiques qui ont eu lieu aux jours internationaux de ce mois."

The following resolution was unanimously approved:—

I.—The Commission recommends that data of the hour and date of all aerological soundings containing observations of temperature should be sent each month to the President in order that he may circulate each month to those interested a complete list of the aerological observations available.

In addition to the monthly report of the results of aerological ascents it is desired that a list of all aerological soundings made on the international days of the month, whether successful or not, should be sent to the President immediately after the end of the month.

(b) Resolution IV of the Vienna meeting. The President reported that in response to a request from the Commission at their meeting in 1925 the International Meteorological Committee had passed the following resolution:—

"Le Comité recommande aux membres des commissions de démissionner quand, pour une cause quelconque, ils cessent de participer à leurs travaux. Si cela est nécessaire, le Président de la Commission leur rappellera cette recommandation et les invitera à s'y conformer."

(c) Resolution XV of the Vienna meeting:—

"In view of the importance, especially for aviation, of fuller information about the frequency and magnitude of vertical currents in each country, the Committee decides that this subject shall be brought specially to the notice of the Commission for the Exploration of the Upper Air. The Committee further recommends that attention should be directed to the importance of a knowledge of the turbulent layers of the atmosphere at stations where observations are made by aeroplane or by kites and kite-balloons."

Dr. Hergesell said that an instrument for recording the variation in the pull of a kite was in regular use at Lindenberg, and he exhibited records from the instruments. A description of the instrument, together with notes of the discussion which followed in which Dr. Moltchanoff, Dr. Cannegieter, Prof. Linke, and Dr. Hesselberg took part is printed as Appendix VI, p. 89.

(d) Resolution LXV of the Vienna meeting:—

"Au cours de la guerre mondiale il y a eu beaucoup plus d'observations aérologiques en Europe qu'il n'en avait été fait avant ou qu'il n'en a été fait depuis. A l'aide des sondages par ballons pilotes répartis régulièrement sur l'Europe entière, le régime des courants (lignes de courants) pourrait être déterminé sur l'Europe pour chaque jour d'une année. Ces observations de courants présenteraient un grand intérêt pour la météorologie dynamique."

"Il serait donc désirable d'obtenir que tous les pays d'Europe qui, pendant la guerre mondiale, ont fait exécuter des ascensions de ballons pilotes dans des buts militaires, rassemblent pour la période du 1^{er} Juillet 1917 au 30 Juin 1918, et pour des stations de sondages distantes d'au moins 100 kilomètres, les résultats d'observations suivants:

(a) Un ou deux sondages au plus par jour (un le matin, un l'après-midi);

(b) la direction et la vitesse du vent (en mètres par seconde) à 500m., 1000m., 1500m., etc., jusqu'à 4000m., au maximum.

Aussitôt, que les résultats de ces observations auront été rassemblés dans les différents pays, on pourra prendre une résolution pour leur dépouillement d'ensemble en vue de fixer le régime des courants sur l'Europe, dans l'année considérée."

Dr. E. van Everdingen said that the copy of the resolution had been issued to all the countries interested, together with a form drawn up by Dr. Exner for the return of the data, up to the present only two replies had been received, one from Hungary and one from Italy.

The President exhibited the result of an attempt which he had made nearly five years ago to co-ordinate the aerological data for Europe for a single week, and said that in view of the magnitude of the task suggested by the resolution it could hardly be carried out by the Bureau without special arrangements. He suggested that some Director might volunteer to undertake the work. He then asked the countries represented to inform the meeting as to what steps had been taken by their institutes to carry out the resolution. The following replies were received:—

Great Britain (Mr. Lempfert). A vast amount of material is available but little has been done towards its co-ordination and publication.

Spain (Colonel Meseguer, Dr. Fontseré). No special observations are available; all the regular observations have already been published.

Sweden (Dr. Wallén). No special observations are available.

Italy. Prof. Eredia said that he had already informed Dr. Exner through Prof. Palazzo that the *Institut de Prévisions du Temps* would be glad to co-ordinate the aerological observations made during the war. He wished to confirm that statement and to give the meeting the assurance that his institute was desirous of assisting in carrying out the decisions of the international meetings.

Germany (Dr. Hergesell). A meteorologist has been specially entrusted with the task of discussing and publishing the material available. In accordance with the resolution passed at Vienna the preparation of the material 1917-8 is receiving special attention. The publication will include data for measurements of condition as well as the results of pilot balloon observations.

Prof. Weickmann drew the attention of the Commission to the aerological material for Turkey which had already been published in "Klima der Türkei III."

France (M. Wehrlé). About 40 daily soundings are available for use in connexion with the work suggested, but the labour of compiling it is so great, at least four months for a full-time assistant, that it is impossible to state when it will be in order.

Russia (Dr. Moltchanoff). Es gibt in Russland verschiedene Institute, welche in ihren Archiven die Kriegsbeobachtungen haben. Um diese zu sammeln, ist es nötig, jemanden Auftrag von der Kommission zu geben, diese Beobachtungen von den verschiedenen Instituten zu sammeln, zu studieren und nach Korrektur der Kommission zuzuschicken.

Austria und Hungary (Dr. Exner). The work on the data is complete.

Denmark (Dr. la Cour). Very few observations are available.

Holland (Dr. van Everdingen). All the pilot-balloon observations available have been published in the *Aerologische Beobachtungen*.

Norway (Director Hesselberg). Only a few pilot balloon ascents were made during the war and these have not yet been published.

Professor Bjerknes said that in 1919 when he was elected President of the Upper Air Commission he had made an effort to collect observations of the kind referred to for a period during the war. He had succeeded in getting observations for a specimen month in 1918 from France and something for other countries. The material collected was sufficient to show that a complete co-ordination of the data would be of extreme interest, but he had found the work involved too many difficulties for him to proceed with it without support.

Sir Gilbert Walker asked that the limitation to Europe suggested by the resolution should not be taken too strictly, and the Commission agreed that observations from neighbouring countries should be included if they could be obtained.

The following suggestion by Prof. Exner was accepted:—

"Wenn der Präsident der Kommission den Staaten Russland, Frankreich, Deutschland, England, Belgien den Wunsch der Kommission mitteilt, die Pilotbeobachtungen möglichst bald einzusammeln, so wäre es gut, hinzuzusetzen, dass die Art der Zusammenstellung nach dem früher schon verschickten Programm von Exner gemacht wird, weil dann eine einheitliche Bearbeitung aller Beobachtungen beabsichtigt ist."

The following resolution was adopted:—

II.—The Commission expresses the hope of seeing as soon as possible a compilation of the pilot-balloon observations in Russia, France, Germany, England and Belgium, and that such compilations should be made in accordance with the patterns already circulated by Prof. Exner because it is intended to proceed to the compilation of all the observations on a uniform plan.

(e)—Resolution LXXVI. of the Vienna meeting:—

"Le Comité prie les présidents des commissions de faire, autant que possible, imprimer les procès-verbaux dans la langue qui a servi à leur rédaction. Il recommande de choisir le même format (celui des procès-verbaux de la Commission de la Haute Atmosphère, 1925, M.O. 281) pour tous les procès-verbaux, y compris ceux du Comité."

Dr. E. van Everdingen said that all the reports received since the resolution had been in the proposed form. The President expressed the gratification of the Commission that the *procès-verbaux* of their last meeting should have been chosen as pattern for the future reports.

Presentation of data.—The compilations of data for September 4th, 1924, January 24th, 1925, and for the international month of May, 1926, together with the tephigrams were circulated to the members for their inspection. Copies of the forms and graphs for the return of data, including a new large-scale form F for tephigrams on millimetre squared paper and specimens of returns from Canada were also exhibited. Prof. Eredia presented to the President copies of the publication "*Sondaggi Aerologici eseguiti nei giorni stabiliti dalla Commissione per la esplorazione dell'alta*"

atmosfera," containing data for Italy for January, May and September, 1926.

Further consideration of Specimen Volume.—The President announced that he would ask the Commission to appoint sub-commissions to consider in detail the four sections of the specimen volume. He then called for general remarks on the publication.

I^{re} Partie, Avant-Propos.—The following documents (Appendix IV, p. 85) were referred to:—

- (1) Letter from Colonel Gold, already circulated to the Commission;
- (2) Memorandum by Prof. Bjerknes, "Concerning the variables of dynamical meteorology and their Units," already circulated;
- (3) Resolution by Dr. L. F. Richardson on absolute temperature.

The documents were referred to the sub-commission on Part I, *Avant-Propos*.

In the course of the discussion, Dr. Linke asked whether it was necessary to introduce the term "tercentesimal scale" in addition to "absolute scale" when the two differed only by 0.03° C. He thought that it was undesirable to introduce too many special meteorological units which would make it more difficult for physicists to co-operate in meteorological work.

Prof. Exner expressed a preference for the use of the centigrade scale of temperature, and the expression of height in metres. Geopotential and temperature on the tercentesimal scale might be given in additional columns.

The President expressed the opinion that meteorology must use terms which make meteorology easy. The term "tercentesimal" was introduced to mean the centigrade temperature with 273 added; that was the established and useful practice when a sufficiently accurate approximation to absolute temperature was required. But, strictly speaking, it was incorrect to use the term absolute temperature for the approximation, another name was therefore desirable. He referred to the publication of the *Réseau mondial*, which had on many occasions received the approval of the International Meteorological Committee, and in which the units were the same as those of the specimen volume, though the symbol "a" was used there for temperature.

Prof. E. van Everdingen expressed the opinion that it was unnecessary to print Part I, *Avant-Propos*, in full on future occasions.

Agreed *nem. con.*

Professor Bjerknes was appointed Chairman of the Sub-Commission for Part I.

II^{me} Partie. Cartes Synoptiques.—Dr. Hesselberg expressed the opinion that it would be possible to avoid the discontinuities in the hour of observation to which the President had referred in the meeting of the previous day.

Prof. E. van Everdingen drew the attention of the Commission to Mr. Cahill's "butterfly-maps" and outlined the principles on which they were based; he asked that they might be taken into consideration by the Sub-Commission.

Mr. Lempfert was appointed Chairman of the Sub-Commission for Part II.

III^{me} Partie. Tableaux.—The President pointed out that the general principles of arrangement of the tables had been decided by the resolutions of the meeting in London, the Sub-Commission would therefore consider only the details of the arrangement.

Prof. Eredia was appointed Chairman of the Sub-Commission for Part III.

IV^{me} Partie. Diagrammes-Indicateurs. Folio des téphigrammes.—Dr. Hesselberg was appointed Chairman of the Sub-Commission for Part IV.

V^{me} Sub-Commission.—The President suggested that a fifth Sub-Commission should be appointed to consider the forms and data already prepared and to co-ordinate the recommendations of the four Sub-Commissions. He proposed that this Sub-Commission should meet under the Chairmanship of Prof. E. van Everdingen, and that it should consist of the chairmen of the four sub-commissions and the following members in addition: Dr. Wallén (Sweden), Col. Meseguer (Spain), Dr. Moltchanoff (Russia), M. Wehrle (France), Dr. Exner (Austria), Dr. D. la Cour (Denmark), Dr. Hergesell (Germany), Dr. Oishi (Japan), Dr. Kimball (United States) and Dr. Róna (Hungary).

The suggestion was approved. A list was circulated for members of the Commission to write their names against the sub-commissions at which they wished to assist.

The meeting adjourned at 12.30.

NAPIER SHAW,
President.

September 3rd, 1927.

Third Business Meeting, Wednesday, 31st August, 1927, at 9.30 a.m.

Present: Sir Napier Shaw (*President*) in the Chair, Director Hesselberg (*Secretary*), Mr. R. G. K. Lempfert (*Secretary*), Dr. H. Arctowski, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. D. la Cour, Prof. F. Eredia, Prof. Dr. E. van Everdingen, Prof. Dr. F. M. Exner, Dr. E. Fontseré, Prof. Dr. Hergesell, Dr. Keil, Dr. H. H. Kimball, Dr. Linke, Dr. Marczell, Dr. E. G. Mariolopoulos, Colonel Meseguer, Dr. P. Moltchanoff,

Dr. W. Oishi, Dr. A. Peppler, Dr. L. F. Richardson, Dr. S. Róna, Mons. Ph. Schereschewsky, Dr. A. Schmauss, Sir Gilbert Walker, Dr. Wallén, Mons. le Capitaine Wehrle, Prof. Dr. L. Weickmann, Dr. P. Zistler.

Correspondence : The President read the following letters :

(a) From *Mr. J. Patterson* (See Minutes of the first meeting, p. 16).

(b) From *Dr. C. F. Marvin*, Chief of the Weather Bureau.

"The Weather Bureau contemplates purchasing a number of the international publications for 1926 and the necessary forms for furnishing to the Commission the aerological data for 1927.

During October, the international month for 1927, the Weather Bureau will make one or more daily sounding balloon observations at the Groesbeck, Texas, aerological station. Continuous kite-flights will be made, if wind and weather conditions permit, on the international days (14th-15th) at our five aerological stations. Special pilot balloon observations will be made from the 14th to 22nd at some 30 stations and special aerological observations by airplanes are also planned."

Further consideration of the specimen volume.—(a) *Cost of the volume :* The President gave the following summary of the cost of compiling and printing the specimen volume up to August 25th :

| | Compilation. | Printing. | Total. |
|------------------------------|--------------|-----------|--------|
| | £ | £ | £ |
| Avant-Propos ... | 15 | 56 | 71 |
| II ^{me} Partie ... | 37 | 130.8 | 167.8 |
| III ^{me} Partie ... | 145.5 | 524.4 | 669.9 |
| IV ^{me} Partie ... | 14 | 73.9 | 87.9 |
| | | | 996.6 |

The cost of 500 copies was approximately £1,000 ; 250 copies would have cost about £900. The selling-price of the volume had been fixed at £2 per copy, which would give £1,000 for the whole number of 500 copies.

The President intimated that he had accepted the responsibility for the order of 500 copies, and had guaranteed £500 towards meeting the account, as representing 250 copies. The cost of 500 copies had been met provisionally by the following contributions :

| | £ |
|---------------------------------------|--------|
| Netherlands Institute ... | 82.6 |
| Director of Lindenberg Observatory... | 24.5 |
| Geophysical Observatory, Leningrad... | 20.6 |
| Sale of copies ... | 16 |
| U.G.G.I. ... | 353 |
| Guarantee (250 copies) ... | 500 |
| | £996.7 |

The 250 additional copies covered by the guarantee would be placed at the disposal of the Commission if the Commission so desired.

NOTE.—A statement of the receipts and expenditure on behalf of the Commission up to October 31st, 1927, and the allocation of funds to the different objects for which the Commission has to provide is given in Appendix I (p. 68).

(b) *Distribution of the specimen volume.*—The President stated that the £500 contributed by the U.G.G.I. had provided for the preliminary expenses and also £353 towards the cost of printing the volume, representing 176 copies, which are at the disposal of the Commission.

In anticipation of the wishes of the Commission 66 copies have already been circulated by the Bureau to members of the Commission, directors who have contributed data to the volume, and certain persons who have been invited to attend the meeting.

III.—The Commission agreed that copies should be circulated to the directors of réseaux who are on the list published by the Bureau of the International Meteorological Committee who are not also members of the Commission.

It was estimated that this circulation would dispose of about 100 copies.

Of the remaining copies, 41 were at the disposal of the Netherlands Institute, 12 at the disposal of the Director of the Aeronautical Observatory of Lindenberg, and 10 at the disposal of the Geophysical Observatory of Leningrad, in consideration of the contributions of those Institutes ; 25 copies had been forwarded to Prague for the meeting of the U.G.G.I., and these might be regarded as being at the disposal of the Meteorological Section there. The President suggested that endeavour should be made to obtain subscriptions towards the remaining copies at £2 per copy.

Dr. Kimball, whom the President welcomed as representative of the Weather Bureau, reported that the Chief of the Weather Bureau would be glad to contribute his share towards the purchase of copies.

Prof. E. van Everdingen stated that the Netherlands Institute would only require 20 of the 41 copies allotted to it, and the President asked for authority to negotiate with Prof. E. van Everdingen as to the disposal of the remaining 21 copies. In the course of discussion Prof. E. van Everdingen explained that the years for which the payments had been made were one year behind the years to which they had been allotted. One half of the payment of £82.6 has accordingly been allotted to the volume for 1924, and only 20 copies of 1923 are allotted in return for the subscription for that year.

(c) *Assessment of contributions from the several countries.*—The President stated that he had estimated that the cost of the volume worked out at about 5s. per line of Part III. On the basis of

payment for the cost of production of material contributed the quota of the countries to the 1923 volume would be as follows:—

| REGION A— | | £ | £ | REGION C— | | £ | £ |
|---------------|---|---|-------|---------------|---|---|-------|
| United States | - | - | 182 | Azores | - | - | 54 |
| Canada | - | - | 13 | Bulgaria | - | - | 30 |
| | | | — 195 | Egypt | - | - | 14 |
| REGION B— | | | | France | - | - | 74 |
| Brazil | - | - | 43 43 | Germany | - | - | 81 |
| REGION D— | | | | Great Britain | - | - | 20 |
| Ceylon | - | - | 26 | Holland | - | - | 69 |
| British India | - | - | 1 | Italy | - | - | 117 |
| | | | — 27 | Norway | - | - | 70 |
| REGION E— | | | | Russia | - | - | 121 |
| South Africa | - | - | 20 20 | Spain | - | - | 68 |
| REGION F— | | | | | | | — 718 |
| Australia | | | 52 | | | | |
| New Zealand | - | - | 15 | | | | |
| | | | — 67 | | | | |
| | | | £352 | | | | £718 |

giving a total of £1,070.

The Commission agreed with the President that such a method of assessment was not desirable.

He estimated that the cost of a future volume might be about £2,000; the estimate of the cost made at the Bergen meeting for the maintenance of an international establishment and for printing was £4,000.

In 1921 the matter had been referred to the International Meteorological Committee, and in response to a circular asking for the opinion of directors as to the sums they would be able to contribute, the following had been suggested* :—

| | | £ | | | £ |
|---------------|-----|---------|-------------|-----|----|
| Canada | ... | 100 | Holland | ... | 40 |
| Denmark | ... | 40 | India | ... | 80 |
| Finland | ... | 20 | Switzerland | ... | 18 |
| Great Britain | | 300-400 | | | |

giving a total less than £2,000.

At the meeting of the International Committee in 1921 the directors present had been asked to estimate the number of copies which would be required by their institutes, and the following replies had been received† :—

| | | | | | |
|---------------|-----|----|--------|-----|----|
| Denmark | ... | 10 | Japan | ... | 80 |
| Great Britain | ... | 75 | Norway | ... | 15 |
| Holland | ... | 20 | Sweden | ... | 20 |

giving a total of less than 500 copies.

The President said that the difficulty of obtaining subscriptions was due to the fact that until the present time it had not been possible to put before the directors of meteorological services a specimen of the volume to and for which they were asked to contribute.

* "Report Int. Met. Conf. of Directors, Utrecht, 1923," p. 83.

† "Report Int. Met. Committee, London, 1921." (M.O. 248), p. 26.

Prof. E. van Everdingen reminded the members that at the International Meteorological Conference at Utrecht in 1923 (Report, p. 57), "information was obtained of about 10,000 frs. gold (£400) probably available in the form of fixed contributions from countries, in addition to those already referred to by the President."

Colonel Meseguer said that Spain would be willing to contribute the cost of 20 copies.

Prof. Eredia said that the Italian Government might be unwilling to contribute to a publication the text of which was not published also in one of the Latin languages.

Prof. E. van Everdingen pointed out that it was only the Avant-Propos which required translation. The maps, diagrams and figures were all international, as were also the symbols used in the tables and forms.

Colonel Meseguer also emphasized the difficulty of language at the meetings, and asked that a précis of the speeches might be given in French as some representatives of Latin origin did not understand either German or English.

The President said that he was most willing to comply with the request.

International Publication: Finance.—Dr. Hergesell made the following statement :—

Man habe sich von den Schwierigkeiten der Finanzierung wohl nur ein unvollständiges Bild gemacht, bis der Präsident der Internationalen Kommission sie allen Mitgliedern durch seine vorangehenden Ausführungen klar gemacht. Aber nachdem nun über diese Schwierigkeiten Klarheit bestände, müsse man wohl dem Präsidenten grossen Dank für seine schwierige Arbeit aussprechen, dass er eine so wertvolle Publikation trotz allem habe fertigstellen können, die auch die thermodynamische Verwertung des Materials zum ersten Mal in ausgesprochener Weise umfasste.

Die Sammlung der Geldmittel ist immer eine grosse Schwierigkeit gewesen, aber wenn man sich dessen bewusst sei, was mit den Mitteln geschehen soll, dann müsste es auch möglich sein, die Mittel im Betrage von etwa RM. 50 000 aufzubringen. Diese Zahl ist wohl anzunehmen, wenn man die weitere Entwicklung der Aerologie seit dem Jahre 1923 in Betracht zöge.

Man muss auch das Ergebnis der Wiener Konferenz des Internationalen Komitees berücksichtigen, das die Einrichtung eines Sekretariats beschloss: dieses Sekretariat wird über kurz oder lang auch schliesslich die internationalen Publikationen unterstützen.

Herr Schmauss hat bereits auf einen Punkt hingewiesen, der von grosser Bedeutung ist: die Arbeit des einzelnen Wissenschaftlers. Vor dem Krieg boten die "blauen Hefte" für eine grosse Zahl von umfassenden Arbeiten das Material und dieses Material muss unter allen Umständen auch durch die fernere Publikation gegeben werden. Als Grundlage für alle weiteren Untersuchungen könne man vielleicht manches aus den Heften fortlassen und damit Ersparnisse erzielen. Er denkt an die von Lindenberg ausgegebenen "Aerologischen Berichte," die auf kleinstem Raum eine Darstellung aller in der Region C erreichbaren Messungen aus der Atmosphäre geben. Das Schema müsse naturgemäss noch variiert werden, aber er sehe in einer derartigen schematischen Darstellung den Ausweg für eine Reduzierung der Kosten.

Seinerzeit in Petersburg sei auch die Frage der Finanzierung ein sehr schwieriger Punkt gewesen und doch habe man die Mittel für die Publikation gewonnen. Seit dem Jahre 1912, wo etwa RM. 12 000 zur Verfügung standen, sind die Druckkosten ganz gewaltig gestiegen, daher ergibt sich eine Erhöhung des Fonds von selbst. Andererseits hat aber auch der Umfang der aerologischen Arbeiten sehr erheblich zugenommen. Allerdings ist der Kreis der Interessenten ebenso gewachsen. Anstelle der 19 Staaten von 1913 haben wir heute mit allen Instituten der Erde zu tun, daraus ergibt sich von selbst auch eine Möglichkeit zur Aufbringung von Mitteln in grösserem Umfange.

In diesem Sinne habe er seine Anträge an die Kommission gemacht ; nämlich :

(1) Die Beobachtungen in der freien Atmosphäre in den internationalen Tagen werden durch den Präsidenten der Kommission international veröffentlicht. Um die Kosten des Druckes aufzubringen verpflichtet sich jedes Land, welches an den Arbeiten der Erforschung der freien Atmosphäre teilnimmt, bzw. an den Arbeiten Interesse hat, eine bestimmte Anzahl dieser Publikationen zu kaufen und zwar zu einem Preis, der von dem Präsidenten der Kommission festgesetzt wird.

(2) Dieser Preis muss so berechnet werden, dass die Kosten vollkommen aufgebracht werden.

(3) Er wird sich nach der Anzahl der Internationalen Tage und nach der Ausführung der Publikation richten. In den Beratungen in Leipzig wird dieses näher festzustellen sein.

Er bittet die Vorschläge in dem angegebenen Sinne zu diskutieren, da er nur damit einen Fortschritt der nun schon seit Jahren behandelten Fragen sieht.

Endlich weist er darauf hin, dass noch etwa 14 000 Hefte der Internationalen Publikation von 1901-1913 in Lindenberg lagert. Er wird sich freuen den neuen Mitgliedern der Kommission diese Publikation zur Verfügung zu stellen.

Professor E. van Everdingen a ecouté le discours de M. Hergesell avec beaucoup de sympathie. Il ajoute seulement deux remarques :—

Le Comité météorologique international a déjà sanctionné dans la séance de Vienne, le projet assez détaillé du volume d'essai qui est devant nous. Il n'est pas nécessaire selon lui de consulter le Comité de nouveau, si on publie des volumes suivants selon un projet mais un peu modifié.

D'autre part, il lui semble absolument nécessaire de continuer dès maintenant la publication d'un volume annuel, nécessité qui était le grand motif pour la Commission de coopération intellectuelle sous la présidence de M. le Prof. Lorentz pour s'intéresser à notre oeuvre. Pour cette raison il propose d'employer pour le volume 1924 une forme à peu près analogue à celle de 1923 et d'employer le temps nécessaire à l'impression pour discuter les changements nécessaires pour réduire les frais de futurs volumes. D'ailleurs la question de la composition doit être encore discuté par la sous-commission sous la présidence de M. Eredia.

The President asked the opinion of the Commission as to whether there should be one publication for each of the several regions or a single publication for the whole world.

Dr. Hergesell said that he thought

IV. that each Vice-President should compile the data for his own region in due form, which he should forward to the President, who would combine the parts contributed by the regions into a single publication.

The Commission concurred in this view.

The President then suggested that Dr. Hergesell's proposals should be accepted, and that an appeal should be drawn up addressed to the official meteorologists of the different countries, and that such an appeal should be signed by the President and past Presidents of the Commission, and by the President of the International Meteorological Committee, Dr. E. van Everdingen. He counselled the members not to exclude anything from the publication which they would wish to include, but to recommend to the directors the form of publication which, in their opinion, was the most desirable in the interests of the science ; he thought that if the form recommended really marked an advance the directors would be willing to support it.

Prof. E. van Everdingen said that he thought it would be easier for some countries to contribute if the wording of the proposals of Dr. Hergesell were slightly modified.

The President proposed the adoption of Dr. Hergesell's resolution, subject to verbal modification to meet Prof. E. van Everdingen's suggestion. The proposal [with modifications subsequently approved in square brackets] is as follows :—

V.—“That observations of the upper air on international days should be published in international form by the President of the Commission. To defray the cost of printing, each country which co-operates in the investigation of the upper air or is interested in that work is urgently requested [either to put at the disposal of the President a fixed annual sum or] to buy a definite number of copies at a price to be fixed for each volume by the President.

The price fixed should be such that after the sale of all the available copies the expenses should be completely covered.

[The countries which put a fixed sum at the disposal of the President should be entitled to receive a number of copies calculated according to the price of the volume.]

Approved.

The President then proposed the following resolution :—

VI.—“That an appeal be formulated to be signed by the President and past Presidents of the Commission and the President of the International Committee, addressed to the Directors of Meteorological Services asking for contributions to the fund necessary to realize the aspiration expressed in the resolutions.”

He undertook the preparation and issue of the appeal as completing the duty attaching to his period of office.

The resolution was unanimously approved.

The Commission adjourned at 12.30 p.m.

NAPIER SHAW,
President.

3rd September, 1927

**Fourth Business Meeting, Thursday, 1st September, 1927,
at 9.30 a.m.**

Present : Sir Napier Shaw (*President*) in the Chair, Director Hesselberg and Mr. R. G. K. Lempfert (*Secretaries*), Dr. E. Alt, Dr. H. Arctowski, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. D. la Cour, Prof. F. Eredia, Prof. E. van Everdingen, Prof. F. M. Exner, Dr. E. Fontseré, Prof. Dr. Hergesell, Dr. Keil, Dr. H. H. Kimball, Dr. Linke, Dr. Marczell, Dr. E. G. Mariopoulos, Colonel Meseguer, Dr. P. Molchanoff, Dr. W. Oishi, Dr. L. F. Richardson, Dr. S. Róna, Mons. Ph. Schereschewsky, Prof. Dr. A. Schmauss, Sir Gilbert Walker, Mons. le Capitaine Wehrlé, Prof. Dr. Weickmann, Dr. P. Zistler.

Correspondence.—Mr. Lempfert read a letter from M. Agostinho, Director of the Meteorological Service of the Azores, expressing his regret at being unable to attend the meeting, forwarding data for the international days in 1926, and ordering two copies of the specimen volume for 1923. A note by M. Agostinho on the results of observations of the oscillations of pilot-balloons is appended to M. Fontseré's report (p. 59).

A copy of the *Correio dos Açores*, published as a memorial to the late Colonel Chaves, was referred to, and was circulated among the members of the Commission.

Reports of Sub-Commissions.—The President read the reports of Sub-Commissions II, *Cartes Synoptiques*, and IV, *Diagrammes Indicateurs*, which had already been circulated. (The reports as modified after consideration by Sub-Commission V, are printed on pp. 42-4)

With regard to the report on Part IV, the President said it was well to distinguish between what is desirable and the provision of the necessary means. He suggested that it would be better for the resolutions as to the form of publication to express the opinion as to what is desirable independently of material considerations. He thought the Commission might like to consider the possibility of making Part III, *Tableaux*, its official publication, and that the publication of Part II synoptic charts for the globe, and Part IV, tephigrams, might prove to be remunerative as a business proposition.

Appeal to Meteorological Institutes.—The President then read the resolution VI passed at the close of the meeting of the previous day (see p. 31), and called the attention of the Commission to the fact that the election of a new President was included in the business of the meeting on Friday morning. The circulation of the appeal to the Meteorological Institutes of the world would bring to an end his duties as President of the Commission. He expressed the opinion that the appeal should take a very definite form.

The present position with regard to the data is as follows :—

1. Forms have been issued as required.
2. Data for 1923 have been collected, co-ordinated and printed.
3. Data for 1924 and 1925 have been collected, and the data for a specimen day of each year have been co-ordinated for the printer.
4. Data for 1926 have been collected, and those for the international month of May have been co-ordinated for the printer.
5. Data for 1927 are being collected.

The President suggested that the work should be continued as heretofore until the data for 1924-7, which have been collected and prepared for printing, have been disposed of. Observers should be asked to change the venue of the data for 1928 onwards and forward them to the new President to be edited under his guidance under instructions laid down by the Commission in accordance with the experience gained.

He expressed the opinion that an appeal on those lines for a well-defined programme would carry conviction. It was preferable that the appeal should be made on the understanding that a series of five volumes would be completed in not more than three years, than to put forward a proposal with an indefinite programme for the near future. If the appeal were successful the new President would have an amount equal to four-thirds of the sum allotted for each of the years 1924-7 for dealing with the material for 1928 and subsequent years.

The President then asked the assistance of the Commission as to the classes of persons for whom the publication should be regarded as designed, and the number of copies that would normally be required. He thought the publication would have a wider circulation than the formal distribution of ordinary meteorological documents. He suggested the following for consideration :—

1. Meteorological institutes.
2. Observing and aerological stations employing professional staff.
3. Schools of meteorology in universities of the old and new worlds, and schools of geography or geophysics, if there is no school of meteorology.
4. 50 copies for other persons interested.
5. 100 in stock.

With regard to Dr. Arctowski's suggestion, contained in the report of Sub-Commission II, that South America, Africa and Australia should be brought into the map of the Northern Hemisphere, the President thought that the actions of the Commission should be directed to encouraging those countries to think of their own hemisphere as one; and up to the present too little appreciation had been shown of the aspirations and requirements of the

countries of the Southern Hemisphere. The presentation of the volume to the Universities of South Africa, Australia and South America might be an important step in the development of the study of meteorology from the most scientific point of view.

The President further asked for the assistance of the members of the Commission in forming an estimate of the cost of providing the material which was included in Part III. The object of the ascents was that they might be available for use by the whole world, and the cost of making them available was minute compared with the original cost of the observations. The members would help the President in giving additional force to the appeal if they would provide him with the information required. Dr. Zistler had already reported that the cost of 56 ballon-sonde ascents at Munich was 7,000 marks (£350), exclusive of the cost of personnel.

The President recalled that the duties of the Bureau under the President's supervision were two-fold, on the one hand to act as General-in-Chief of upper air work, to carry through the arrangements regarding international days, and to advise as to instruments, balloons and methods of investigation; and on the other, the collection, co-ordination and publication of data in the international volume. The two functions are sufficiently distinct to permit of various arrangements for the accomplishment of the work.

Professor E. van Everdingen referred to the resolution of the London meeting and said that the original task of compiling the specimen volume was not restricted to 1923, but was intended to extend to 1924. He was, therefore, in agreement with the President that the 1924 volume should be published by the same organization as the specimen volume for 1923. He thought, however, that difficulties might arise if the arrangement were extended beyond 1924; the funds for which the appeal is to be made would be placed at the disposal of the new president, and as frequent discussion would be required between the president and the editor he thought it desirable that the two should be together. He proposed, therefore, that the preparation of the volumes for 1924 and 1925 should take place simultaneously; the volume for 1924 being in charge of the old organization and that for 1925 in charge of the new president.

With regard to the issue of the volume, Prof. E. van Everdingen thought that many of the institutions mentioned on the President's list would have no interest in the publication; it was desirable to increase the circulation, but it was not necessary to proceed according to a methodical list and thus run the risk of sending copies to many persons who would have neither time nor interest to consult them.

Professor E. van Everdingen added that the new international Secretariat, which was in process of creation, might be able to offer assistance with the work of the volume; it was, in his opinion, undesirable that the Commission should make a large

appeal to directors apart from that which will be made for the international bureau, and it would be unwise for the Commission to dissociate itself from the work of the Secretariat.

The President said that he thought he would be able to draft an appeal which would meet with the approval of the signatories Prof. Bjerknes, Prof. E. van Everdingen, and Dr. Hergesell.

Geopotential and geometric height.—The President referred to Colonel Gold's letter (p. 87) on the subject of geopotential, and asked the Commission to consider the question as to whether the heights recorded in upper air ascents are not really measures of geopotential, and, for example, whether the formulæ for pilot-balloons would be simpler and more coherent if geopotential were substituted for geometric height. After discussion a resolution proposed by the President was slightly modified and approved with one dissentient, as follows:—

VII.—“That steps be taken to call the attention of meteorologists to the records of height in various meteorological operations with the object of ascertaining (1) how far the recorded heights are orthometric or are really geopotential converted into orthometric form by a conventional value for gravity, and (2) what alteration in practice would be necessary to secure a general system for using geopotential instead of height as the vertical co-ordinate.”

Results of the expedition of the Messungs Schiff “Meteor.”—Dr. Hergesell gave a short account of the general results of the expedition (Appendix VII, p. 91).

Aerological ascents and solar radiation.—Dr. Linke read the following paper on solar radiation at high altitudes:—

„Ueber die Bedeutung von Strahlungsmessungen für die Erforschung der hohen Atmosphäre.“

In den letzten Jahren sind von mir und meinen Mitarbeitern nicht nur in meinem Institut sondern auch auf Expeditionen Messungen und Registrierungen der Sonnen- und Himmelsstrahlung zu dem Zwecke ausgeführt worden, die meteorologischen Vorgänge in der Höhe zu verfolgen. Es zeigte sich, dass die Luft je nach ihrer Herkunft und ihrem Sättigungszustand durch bestimmte Extinktionskonstanten für Gesamtsonnenlicht, Rotstrahlung und kurzwellige Strahlung gekennzeichnet ist.

Die Einführung des Trübungsfaktors T nach der neuen Extinktionsformel $J_m = J_0 q_m^{T_m}$, wo q_m der Transmissionskoeffizient ideal reiner und trockener Luft ist, war für diese Betrachtungen sehr förderlich. Es wurde nicht nur ein Trübungsfaktor für Gesamtstrahlung, sondern auch für Rot- und kurzwellige Strahlung eingeführt, deren gleichzeitige Variationen, graphisch dargestellt, Lufterbrüche und bevorstehende Wolkenbildung deutlich erkennen lassen, besonders unter Hinzunahme der Polarisationsgrösse.

Diese Untersuchungen werden am besten an aerologischen Stationen ausgeführt, wo man genau die verschiedenen Luftschichten und ihre Aenderungen über der Station feststellen kann. Die Verbindung von aerologischen und Strahlungsbeobachtungen wird zweifellos weitere wichtige Ergebnisse zeitigen und muss deshalb dringend empfohlen werden.

The following resolution was unanimously approved :—

VIII.—"The Commission considers the arrangement of simultaneous aerological ascents and registration of the sun's and sky's radiation as valuable for understanding the atmospheric processes and warmly recommends the continuation of researches in those subjects."

Experiments by Dr. Schoute.—Prof. E. van Everdingen gave a preliminary report on some experiments carried out by Dr. Schoute, of De Bilt, on a journey to and from South America, on board a Dutch liner. The journey was made possible by a liberal reduction of the cost of passage, some grants, and personal sacrifice by Dr. Schoute. The first experiment was the observation of pilot-balloons with the ordinary registering theodolite of Dr. Schoute, supported on a damped pendulum, which reduces the apparent motion of the balloon due to the ship's motion. The experiment was partly successful in spite of adverse circumstances.

The second experiment was the registration of solar radiation by a registering galvanometer supported in the same way. This met with little success, but a new support has been constructed now, intended primarily for use on board the non-magnetic vessel "Carnegie," and experiments will be made early in September in the North Sea. A full description will follow when the experiments are finished. This communication is only given to indicate interest in the problems which Dr. Hergesell and Prof. Linke have treated.

Specimen volume, Part III, Tableaux.—The President asked for the opinion of the members on any general questions arising out of the tables. Dr. Cannegieter suggested that if the wind-observations were transferred from Table II to Table III it would be possible to put Tables I and II on facing pages, as was the custom in the publications at De Bilt, and had recently been adopted in a publication of the Swedish office.

The President emphasized the difficulty of dealing with international observations as compared with those from one's own country, and of separating information of different kinds which belonged to the same values of the fundamental co-ordinates. He asked Dr. Cannegieter to prepare specimen pages of the arrangement he suggested, so that the details might be evident, and to submit them at the meeting of Sub-Commission III.

The Commission adjourned at 12.30.

3rd September, 1927.

NAPIER SHAW,
President.

Fifth Business Meeting, 2nd September, 1927,
at 10.15 a.m.

Present : Sir Napier Shaw (President) in the Chair,
Dr. Hesselberg, Mr. R. G. K. Lempfert (Secretaries), Dr. E. Alt,

Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. E. van Everdingen, Dr. F. M. Exner, Dr. E. Fontseré, Prof. Dr. Hergesell, Dr. Keil, Dr. H. H. Kimball, Dr. Linke, Dr. Marzell, Dr. E. G. Mariopoulos, Col. Meseguer, Dr. P. Moltchanoff, Dr. W. Oishi, Dr. A. Peppler, Dr. L. F. Richardson, Dr. S. Róna, Mons. Ph. Schereschewsky, Dr. A. Schmauss, Sir Gilbert Walker, Mons. le Capitaine Wehrlé, Prof. Dr. L. Weickmann, Dr. P. Zistler.

Sound of Explosions (see also p. 66).—The Commission approved the following resolution proposed by Prof. Dr. Schmauss :—

IX.—"The Commission for the Study of the Upper Air considers it most important that registering balloon ascents and observations of the propagation of sound from explosions by the method described by Lindenberg or by Mr. Whipple be made in very high latitudes and also in low latitudes in order to obtain information regarding the temperature at very great altitudes."

Aerology and Aeronautics.—Dr. Moltchanoff gave a short account of his paper on "The prospect of development of aerology in connexion with the up-to-date achievements of aeronautics" (Appendix VIII, No. 2, p. 92). After discussion* the following resolution, proposed by Dr. Hergesell, was approved :—

Die Kommission empfiehlt die Benutzung von Luftschiffen mit oberer Plattform zum Auflassen von Registrier- und Fesselballonen. Die Registrierballons können vermöge der grossen Geschwindigkeit des Luftschiffes leicht verfolgt und wiedergefunden werden, die Fesselballone bleiben senkrecht über dem Schiff und können grosse Höhen bis zur Stratosphäre erreichen. Die Methode empfiehlt sich besonders für arktische und Wüstenregionen."

"X.—The Commission recommends the use of dirigible balloons provided with an upper platform from which ascents of ballons-sondes and ballons-captifs may be made.

Owing to the high speed which a dirigible can attain, the ballon-sonde could easily be followed and picked up.

A ballon-captif would remain vertically above the dirigible and could in that way reach the stratosphere.

The method is specially recommended for arctic regions and for desert regions."

Reports of Sub-Commissions.—The Reports are printed on p. 42-4.

(a) *Sub-Commission I.* The report was read by the President.

* In the course of the discussion Professor Hergesell drew attention to the fact that a suggestion to liberate registering balloons from airships had been put forward by him in 1911 and the method of operations described in *Petermanns Mitteilungen*.

Dr. Exner handed in the following memorandum signed by Schmauss, Moltchanoff, Richardson, Peppler, Linke, Róna, Alt, Exner, Eredia, la Cour, Hergesell, Walker and Kimball.

The undersigned are of opinion that at the present time dynamical problems are of the highest interest and the publication of aerological data in terms of geopotential may have many advantages, but on the other hand it may be dangerous to neglect entirely the geometric height when investigations on climatology, propagation of sound or optical and electrical phenomena may be made.

Dr. Kimball added a rider advocating the use for a time of both values in publications.

The memorandum was handed to Dr. van Everdingen for consideration by Sub-Commission V, together with the memorandum by Prof. Bjerknes.

With reference to the future publication of Part I, Mr. Lempfert proposed the following resolution which was approved :—

XI.—“In future volumes of the international publication, the Introduction and the explanation of the symbols and abbreviations used in the tables and charts shall be printed in two languages at least.”

The President explained that in the specimen volume, lack of time had prevented the publication of the *Avant-Propos* in two languages, and the nearest that he had been able to approach to that ideal was to print partly in English and partly in French.

The reports of Sub-Commissions II–IV were read and all the four reports were handed to the President of Sub-Commission V for the consideration by that Sub-Commission. The President asked that the attention of the Sub-Commission should be given to the forms for the return of data and emphasized the necessity of having also a “working-form” for the compiler.

Place of next meeting.—Colonel Meseguer expressed his thanks to Dr. Weickmann for his kindness during the meeting. He said that it would be a great pleasure to him to attend future meetings of the Commission in whatever country they were held, but he would like to give a very cordial invitation to the Commission to hold the next meeting in Spain. He could assure the members that if they decided to meet there they would receive a very warm welcome.

The President in thanking Col. Meseguer for this invitation and hoping that it might be accepted, said that it was hardly possible at present definitely to fix the place of the next meeting which must depend to some extent on the circumstances at the time. He had himself visited Madrid and with that experience in mind would be very glad to accept Col. Meseguer's invitation.

Election of President.—M. le Capitaine Wehrle made the following proposal on behalf of the French delegation :—

XII.—“Devant la décision irréductible de Sir Napier Shaw, que nous regrettons tous, étant donné les éminents services qu'à la tête de cette commission il a rendus à la science nous sommes obligés de faire un choix. Il nous semble qu'il y a ici une personnalité particulièrement désignée pour ces

fonctions importantes. D'abord il les a déjà remplies de la manière la plus distinguée avant les tristes événements qui ont bouleversé le monde. Il dirige un institut dont l'activité aérologique joue un rôle mondial. Il représente la tradition des débuts de l'exploration scientifique de la haute atmosphère et d'autre part chacun sait que l'école qu'il dirige fait la place la plus large aux idées modernes. Dans sa longue carrière il a prouvé qu'il était à la fois—et cette alliance est particulièrement précieuse pour la direction de nos travaux—un homme de recherches et un organisateur. Enfin la délégation française verrait avec plaisir dans cette élection une témoignage de l'effacement définitif, dans le domaine météorologique, du trouble causé par la guerre. En nous proposant d'élire comme nouveau président M. le Geheirat Hergesell, la délégation française ne doute pas d'être fidèle à la mémoire de l'illustre initiateur de l'exploration de la haute atmosphère Teisserenc de Bort à l'oeuvre de qui M. le Geheirat Hergesell a toujours rendu si largement hommage.”

Prof. E. van Everdingen said he had much pleasure in seconding the proposal. He referred to the great services which Sir Napier Shaw had rendered to international meteorology; and on behalf of the Commission thanked him especially for his work in connexion with the Commission.

The President said that he regarded it as very fortunate that Dr. Hergesell could resume the position he had filled with such distinction before the war; for many years meteorologists had looked to him as Captain-in-Chief of aerological work, and he felt sure the Commission would welcome the proposal.

The election was unanimously approved and received with acclamation by the Commission.

Dr. Hergesell expressed his grateful appreciation at his election and also for the manner in which the proposal had been put forward. He felt some doubt whether he would be able to realize the expectations of the Commission as the passage of years had not left him untouched. He would always consider the retiring president, Sir Napier Shaw, a shining example, he would make it his endeavour to follow in his footsteps. Above all things he asked for the confidence of members of the Commission and for the co-operation of the Bureau, particularly of Messrs. Hesselberg and Lempfert.

Election of Deputy-President of Region D.—The President proposed :—

XIII.—That Dr. C. W. B. Normand, who has succeeded Mr. J. H. Field as Director-General of Indian Observatories, be appointed Deputy-President for Region D.

The proposal was unanimously approved.

The meeting was adjourned at 11.45 in order that a meeting of Sub-Commission V might be held.

NAPIER SHAW,
3rd September, 1927. President.

**Sixth Business Meeting, Friday, 2nd September, 1927,
at 3.30 p.m.**

Present : Sir Napier Shaw (*President*) in the Chair, Dr. Th. Hesselberg, Mr. R. G. K. Lempfert (*Secretaries*), Dr. E. Alt, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. E. van Everdingen, Dr. F. M. Exner, Dr. E. Fontseré, Dr. H. Hergesell, Dr. Keil, Dr. G. Marczell, Dr. E. G. Mariolopoulos, Col. E. Meseguer, Dr. P. Moltchanoff, Dr. W. Oishi, Dr. A. Peppler, Dr. S. Róna, M. Schereschewsky, Dr. A. Schmauss, M. le Capitaine Wehrlé, Dr. L. Weickmann, Dr. P. Zistler.

Documents circulated :—(a) Minutes of the Third Business Meeting.

(b) Reports of Sub-Commissions II and IV.

(c) Resolutions of meetings from August 29th to September 1st.

The President read the resolutions of Sub-Commission V, which were to be considered later in the meeting.

Choice of international days.—Dr. Exner referred to a memorandum which had already been circulated (Appendix X, p. 95) as to the desirability of choosing the international days at short notice in order to study special atmospheric conditions. He put forward the following proposal :—

“Dass in Hinkunft die internationalen Aufstiege über Europa, der Mehrzahl nach, für bestimmte, besondere Wetterlagen benützt werden sollen. Hiefür wäre es nötig, dass die Institute ihr Aufstiegsinstrumentarium vollständig in Vorbereitung haben und durch telegraphische Nachricht seitens des Präsidenten der Kommission für solche Aufstiege verständigt werden.”

and read the following note from the U.S. Weather Bureau with regard to it :—

“The Weather Bureau is heartily in favour of Dr. Exner's proposal to have the international days selected with reference to the meteorological situation at the time, but instead of designating the same days for the entire world it is believed it would be better to select them with reference to conditions existing in the various regions, and that, therefore, the Vice-Presidents designate these days for their respective regions.”

The President referred to the previous resolutions of the Commission on the subject of international days at the meeting in Bergen in 1921 and in London in 1925.

Dr. Hergesell stated that the scheme of arranging ascents by telegraph had been tried before the war but had not been found to work very satisfactorily. He was, however, very willing to try the experiment again and asked for the co-operation of Dr. Exner in the work. He suggested, however, that the present arrangement of days should be continued, but that the Commission should give authority to the President to make minor changes.

A discussion followed in which Dr. Hergesell, Dr. Schmauss, Dr. E. van Everdingen, Dr. Hesselberg, and Dr. Weickmann took part. Several speakers referred to the difficulty experienced by observers in making ascents at short notice, and also expressed the opinion that it was undesirable to increase to any great extent the number of international ascents. Dr. Weickmann suggested that January and June would be more suitable for the international months than May and October, which had been chosen up to the present.

Dr. Hesselberg spoke in favour of the continuation of the general arrangement of international days adopted at Bergen in 1921, and pointed out that by choosing the days according to that method the month of any one name would become the international month once in every twelve years.

The President stated that in the ordinary course March would be the international month for 1928, and proposed :—

XIV.—“That the choice of days for the six ascents placed at the President's discretion should no longer be limited to the international month, and that he be at liberty to make slight alterations in the selected groups of days if he should think it desirable.”

The proposal was approved.

The extension to 1936 of the scheme for international ascents approved at the Bergen meeting is set out in the table below :

| J | F | M | A | M | J | J | A | S | O | N | D |
|-------|-------|-------|-------|------|-------|-------|------|-------|------|-------|-------|
| | | 1928* | | | | 1928 | | | | 1928 | |
| | | | 1929 | | | 1929 | | | | | 1929* |
| 1930 | | | | 1930 | | | | 1930* | | | |
| | 1931* | | | | 1931 | | | | 1931 | | |
| | | 1932 | | | | 1932* | | | | 1932 | |
| | | | 1933* | | | | 1933 | | | | 1933 |
| 1934* | | | | 1934 | | | | 1934 | | | |
| | 1935 | | | | 1935* | | | | 1935 | | |
| | | 1936 | | | | 1936 | | | | 1936* | |

According to Resolution XX of the Bergen meeting “the days for the international aerological researches should lie in the middle weeks (Monday to Saturday) of the months given in the scheme, in which the years which are printed fat refer to the 3-day periods.” The practice has been in the case of the 3-day periods to select the Tuesday, Wednesday and Thursday of the middle weeks of the selected months.

The asterisks indicate the years for which the corresponding months are the international months, when the co-operating observers are invited to make daily soundings with balloons-sondes as far as possible on consecutive days, beginning with the first day of the month.

Honorary President.—Dr. Hergesell having occupied the chair, at the President's request, Dr. Mariolopoulos proposed the following resolution on behalf of MM. Meseguer, Wehrlé, Weickmann and himself.

XV.—“In order to mark our high appreciation of the services which Sir Napier Shaw has rendered to the science of meteorology and to the Commission during his tenure of the office of President, we beg to propose that he be elected Honorary President of the Commission.”

The resolution was received with acclamation by the Commission.

Dr. Hergesell said that the manner in which the resolution had been received testified to its popularity. The gentlemen who had proposed the resolution had anticipated him, for it had been his intention to make a similar proposal, but he had thought it more appropriate to defer taking action until the final meeting. It afforded him great pleasure to greet the new Honorary President.

Sir Napier Shaw expressed his thanks to the proposers of the resolution, to Dr. Hergesell, and to the Commission for the cordial way in which they had supported it.

Confirmation of resolutions.—Sir Napier Shaw having resumed the chair, Resolutions I—XIII of the previous sessions which had been circulated in English or German and French were finally adopted.

A complete set of the conclusions of the meeting is printed in French as Appendix XI, p. 96. For facility of reference conclusions (Nos. III and IV, XII, XIII, XIV) agreed upon at the previous sessions are included, although they were not formally reported for confirmation.

Report of Sub-Commission V.—The conclusions of the Sub-Commissions I to IV, as modified by Sub-Commission V, were reported to the meeting as follows; the resolutions incorporated therein were unanimously confirmed by the Commission.

Sub-Commission I.

XVIII.—1. As co-ordinates are to be used the geographical longitude, the geographical latitude, and the geopotential.

2. The following units are to be used in the forms and publications of the Commission :—

Latitude in degrees and minutes.

Longitude in degrees and minutes, reckoned from Greenwich.

Geopotential in dynamic metres above sea-level.

Time in G.M.T.

Lengths in metres.

Barometric pressure in millibars.

Temperature in degrees absolute ($273 + C.$)* and tenths.

Potential temperature in degrees and tenths, reduced to 1,000 mb.

Vertical temperature-gradient (lapse-rate) in degrees and tenths per 100 dynamic metres.

Humidity as relative humidity in per cent.

* The words in brackets do not appear in the original draft of the report of the sub-commission, but were added with the approval of the meeting during the reading.—R.G.K.L.

Wind-direction either in degrees from the north or on the scale 01-36, where 36 is wind from north and 09 wind from east.

Wind-velocity in metres per second.

Cloud-forms on the international scale.

Direction of cloud-drift on the scale 01-36.

Angular velocity of cloud drift in unit $1,000 V/H'$, where V is velocity in metres per second and H' is height in metres.

Amount of clouds on scale 0-10, separately for each form.

Weight of balloons in grammes.

Ascensional force of balloon in grammes.

Diameter of balloon in centimetres when filled.

3. The ascents are to be performed as nearly as possible at one or more of the hours 01, 07, 13, 19 G.M.T.

4. The pressure, the temperature, and, if possible, the humidity are to be given (1) for all geopotentials where there are notable alterations in the lapse-rate, (2) for standard pressures 1,000, 900 . . . 100 mb., and (3) for standard geopotentials 500, 1,000, 1,500, 2,000, 3,000 . . . geodynamic metres.

5. The wind is to be given for the station and for the layers of geopotential with approximately homogeneous wind.

6. The Sub-Commission considers that the numerical tables are the most important part of the publication, then the tephigrams, and finally the charts of pressure.

7. Heights should not be entirely eliminated from the publication. The method of inserting them should be studied by the Sub-Commission which will also consider the tables.

Sub-Commission II.—Mr. R. G. K. Lempfert (*Chairman*), Dr. Arctowski, Colonel Meseguer, Dr. Mariolopoulos.

1. The question of the use of a uniform unit was discussed. The Sub-Commission recommended :—

XIX.—1. “That the attention of those entrusted with the editing of similar maps in the future be drawn to the desirability of drawing the isobars on a uniform system of units, millibars, or millimetres for all areas.

2. The Sub-Commission takes note of the discontinuities in time and requests the International Meteorological Committee and the Synoptic Weather Commission to keep the requirements of the Upper Air Commission in mind and not to relax their efforts to secure uniformity.”

The Sub-Commission discussed the question of projection to be adopted. Dr. Arctowski expressed the opinion that the possibility of representing South America and Australia on the same map as the Northern Hemisphere should be considered.

3. The Sub-Commission was much interested in the "butterfly" maps submitted by Mr. Cahill. They consider, however, that further study of the application of the method to the setting out of meteorological data should be made before any resolution is put forward regarding its adoption in the work of the Commission.*

4. The list of data should be retained or transferred if necessary to the part devoted to the tables.

Sub-Commission III.—Prof. F. Eredia, *Chairman*.

XX.—A small sub-commission should be appointed to consider the best form for the publication and the schedules. Members :—MM. the President, Exner, Gamba, Lempfert, Cannegieter, Hesselberg.

The report of the sub-commission should be submitted to the Deputy-Presidents.

Sub-Commission IV.—Dr. Th. Hesselberg (*Chairman*), Dr. E. van Everdingen, Dr. H. G. Cannegieter, Prof. V. Bjerknes, Dr. D. la Cour, Dr. F. M. Exner, Dr. Linke, Dr. Weickmann.

XXI.—The Sub-Commission is of opinion that the tephigrams should be given in the future international publication as a supplement to the tables as far as funds permit.

Sub-Commission V.

XVII.—It is desirable that the volume for 1924 should be prepared for printing in the same form as that for 1923, or in a form not very different. After having received the report of the Sub-Commission on tables the Bureau will decide what action shall be taken with regard to subsequent years.

Approval of the specimen volume.—The following resolution was unanimously approved :—

XVI.—"That with the slight modifications referred to in the reports of the several Sub-Commissions the Commission approves the specimen volume of 1923."

The meeting adjourned at 5.30 p.m.

NAPIER SHAW,
President.

3rd September, 1927.

* A resolution concerning the scale and projection of charts recommended for international use was recorded as Resolution 34 of the meeting of the International Meteorological Committee in London in 1921.

Seventh Business Meeting, Saturday, 3rd September, 1927,
at 9.45 a.m.

Present : Sir Napier Shaw (*President*) in the Chair, Mr. R. G. K. Lempfert (*Secretary*), Dr. Alt, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. E. Fontseré, Dr. H. Hergesell, Dr. Keil, Dr. Marczell, Dr. E. G. Mariolopoulos, Col. E. Meseguer, Dr. Moltchanoff, Dr. S. Róna, Dr. L. Weickmann.

Membership of the Commission.—Dr. Hergesell proposed that Dr. Keil be elected a member of the Commission, and the proposal was unanimously approved.

Procès-Verbaux.—The minutes of the meetings of 29th August to 1st September, which had been circulated, were approved with slight verbal alterations, and signed.

The minutes of the fifth and sixth business meetings of Friday, 2nd September, were read by the Secretary and signed as correct by the President.

Change of President.—Sir Napier Shaw announced that with the completion of the *Ordre du Jour* his formal duty as President of the Commission was ended. He introduced Dr. Hergesell to the duties of the office.

Dr. Hergesell took the Chair and thanked the Commission for electing him President, and said he would do his best to carry out the wishes of the Commission. On behalf of the Commission he again expressed the cordial thanks of the members to Sir Napier Shaw, late President of the Commission and now its Honorary President, for his work for the Commission.

Sir Napier Shaw proposed the following resolution :—

XXII.—The Commission desires to place on record its deep sense of obligation for the excellent arrangements made by Prof. Dr. Weickmann for the meetings of the Commission and for the whole-hearted devotion of the staff of his Institute to its many needs. It also records its cordial thanks to the Leipziger Messamt for the admirable arrangements made for the accommodation of the members of the Commission during the week of the meeting while the heavy requirements of the Messe had also to be satisfied.

Further, it records its high appreciation of its reception by the Saxon Government, the Government of the Reich, the University and the City of Leipzig.

The Commission points with gratitude to the cordial nature of the whole of its proceedings as an anticipation of the deeper appreciation of many kindnesses which it confidently hopes will be expressed more fully by the influence which the meeting will have upon the development of the study of the higher atmosphere.

In proposing the resolution, Sir Napier Shaw expressed his cordial thanks for the honour conferred on him by his election as

Honorary President, and his personal sense of gratitude to the University and City of Leipzig.

The resolution was passed with acclamation.

Dr. Weickmann briefly acknowledged the resolution of thanks.

An informal conversation took place as to the printing of the report of the meeting. It was agreed that it was desirable that the report should appear in more than one language, and the matter was left to be arranged by correspondence between the officers and Dr. Weickmann.

The meeting adjourned at 11.15 a.m.

R. G. K. LEMPFFERT.
Secretary.

NAPIER SHAW,
Honorary President.

11 February, 1928.

MINUTES OF PROCEEDINGS

AT

SCIENTIFIC MEETINGS

First Scientific Meeting, Monday, 29th August, at 2.30.

At the request of the President the Chair was taken by Dr. Hesselberg.

Present : Sir Napier Shaw (*President*), Dr. Hesselberg, Mr. R. G. K. Lempfert (*Secretaries*), Dr. Alt, Dr. H. Arcowski, Prof. V. Bjerknes, Dr. H. G. Cannegieter, Dr. D. la Cour, Prof. Dr. E. van Everdingen, Prof. Dr. F. M. Exner, Dr. E. Fontseré, Prof. Dr. Hergesell, Dr. Keil, Dr. Kölzer, Fr. Dr. Lammert, Dr. F. Linke, Dr. G. Marzell, Dr. E. G. Mariolopoulos, Colonel Mese-guer, Dr. P. Moltchanoff, Dr. W. Oishi, Dr. A. Peppler, Dr. S. Róna, Mons. Ph. Schereschewsky, Dr. A. Schmauss, Sir Gilbert Walker, Dr. A. Wallén, Mons. le Capitaine Wehrlé, Prof. Dr. L. Weickmann, Dr. P. Zistler.

The following papers were read :—

(1) By Mr. R. G. K. Lempfert, on behalf of the President :—

The most recent forms of thermodynamic diagrams for the atmosphere.
With tables for the plotting of temperature-entropy diagrams from the readings of temperature and pressure in a sounding of the upper air.

BY SIR NAPIER SHAW.

The form adopted for the thermodynamic diagram which has been in use under the name of tephigram as Form B since the meeting of the Commission in London in 1925, was arrived at through the graphic evaluation of entropy as the natural logarithm of potential temperature. For temperature, which is represented by abscissæ, the scale is a millimetre to one degree tercentesimal or centigrade. For the logarithmic scale of the ordinates, which represent potential temperature, an extension of the logarithmic scale of temperature in the original diagram of log (pressure), log (temperature), known to the Commission as Form C, was employed. The logarithmic scale for temperature was a simple multiple ($2\frac{1}{2}$) of the scale of pressure taken from a 25cm slide rule. The multiple was selected to facilitate the accurate reproduction of the form. The relation of the entropy and temperature scales was accepted with satisfaction because the run of the isobaric lines on the diagram was actually at 45° to the axes in one part and differed but little from that angle in other parts of the form.

The use of that ratio, however, made it necessary to print special semi-logarithmic paper as the foundation grid of the form. It has the disadvantage in the representation of entropy of spacing the values so that one centimetre represents 0.372 million ergs per gramme degree.

ENTROPY-TEMPERATURE DIAGRAM ON ORDINARY MILLIMETRE PAPER.

In order to plot observations obtained by aeroplanes, and for the study of details of soundings with ballons-sondes, it seemed desirable to enlarge the form. We therefore aimed at expanding the size so that one degree was represented by 2 mm, or by 5 mm, with corresponding

expansion, two-fold or five-fold, of the logarithmic scale of potential temperature. When making a change of this kind it seemed also possible to make the slight adjustment in the vertical scale which was necessary to give a round number to the figure representing the *change of entropy per centimetre*. Two-fold magnification would give $\cdot 186 \times 10^6$ units to a centimetre, and five-fold magnification $\cdot 744 \times 10^5$ units. The reduction of the scale of entropy in the original to give 5×10^5 units per centimetre would give a million units for four centimetres on the two-fold magnification and a million units to ten centimetres for the five-fold magnification. On the original paper the entropy-scale of 2 cm to a million units thus indicated would take the place of the entropy-scale of Form B; the temperature-co-ordinate would be unaltered.

The modification thus suggested would make it easy to plot the entropy-temperature diagram of a sounding upon ordinary millimetre paper, using the values of entropy and temperature instead of potential temperature and temperature.

The advantage of a step of that kind was made more apparent when the evaluation of geodynamic height from the run of lines connecting points on the diagram was considered.

In order to preserve the scheme of reference which is characteristic of the tephigram it was necessary to re-compute and re-plot the ground-work of Form B which includes the isobars for steps of 100 mb. (or of 10 mb.) beginning with the standard 1,000 mb., the adiabatic lines for saturated air, and the lines of vapour-content for a kilogramme of dry air loaded with moisture to saturation.

In the course of the re-computation and re-plotting the diagram has shown some interesting properties.

The change of entropy from any one point to any other can be represented by the equation.

$$E - E_0 = c_p \log_e 10 \left\{ (\log t - \log t_0) - \frac{\gamma - 1}{\gamma} (\log p - \log p_0) \right\} \\ = 10^7 \{ 2 \cdot 3263 (\log t - \log 100) + \cdot 66532 (\log 1000 - \log p) \}.$$

Entropy can therefore be computed by adding the equivalent of the decrease of pressure from the standard of 1,000 mb. to the entropy which corresponds with 1,000 mb. at the given temperature. The value which is to be assigned at 1,000 mb. for any temperature is obtained from that at any other temperature by a logarithmic scale. The two logarithmic scales have been tabulated. Thus the computation of entropy can be effected directly from the observed values of pressure and temperature without going through the process of computing the potential temperature at all. Tables for the purpose of computation are given at the conclusion of this paper.

It also follows that the increase of entropy and therefore the increase of ordinate in the diagram for a *given pressure-difference* is the same at every temperature. The succession of isobaric lines can be set out for any range of temperature by a graduated rule with the successive points of the line of 1,000 mb. for its starting-points; and the base line of 1,000 mb. can be set out on millimetre paper by the use of a logarithmic scale which gives the entropy ordinate for successive temperatures measured from 100 tt at which the zero of entropy is placed.

PLOTTING FROM OBSERVED PRESSURES AND TEMPERATURES BY SLIDE-RULE.

These properties make it possible to use a slide-rule which is easily constructed to obtain the entropy-temperature diagram from the original readings of pressure and temperature.

[A rough specimen of such a slide-rule for two-fold millimetre paper was exhibited.]

PLOTTING ON A "SKEW" PRESSURE-SCALE.

Another arrangement of the process makes the work of drawing the tephigram even simpler.

We have explained that the entropy can be set out as a distance on a logarithmic pressure-scale from the 1,000 mb. line, adjusting the position of the 1,000 mb. datum-point according to the temperature. If the datum-line is set out beforehand on the millimetre paper the lines for successive pressure-intervals can be drawn with each line throughout its length equi-distant along the vertical from the datum-line. We thus get a "skew" form on which a plot of pressure and temperature gives the entropy-temperature curve without any other necessity than a proper graduation for pressure.

GEOPOTENTIAL ON THE DIAGRAM.

On the temperature-entropy diagram geopotential changes from its value at the point of departure by any movement to a point at different temperature or different entropy or both.

If the temperature is constant the geopotential at any height is proportional to the change in the logarithm of the pressure, and thence it follows that, along a line of constant temperature, geopotential is related to entropy by the equation

$$\Gamma(E) - \Gamma(E_0) = t(E - E_0).$$

Change of geopotential is therefore proportional to the distance along a line of constant temperature on the tephigram (which is simply a vertical line) and the factor of proportion is the temperature.

It follows that the geopotential increases uniformly along each line of temperature with a different factor for each temperature, and the geodynamic heights can be marked on a uniform scale for the two vertical lines which form the frame of the diagram.

If the entropy remains constant geopotential increases with lapse of temperature and proportionally to the change. The formula for this change

$$\Gamma(t) - \Gamma(t_0) = 10 \cdot 10 \text{ million C.G.S. units for each degree of lapse of temperature.}$$

When entropy increases simultaneously with fall of temperature the increase of geopotential is made up of the two terms $\Gamma(t)$ and $\Gamma(E)$. This gives 10·10 million C.G.S. units for each degree of change of temperature + $\int t dE$. For this integral we may substitute $t_0(E - E_0)$ minus the equivalent of the area between the curve the initial ordinate t_0 and the initial and final entropy lines E_0 and E .

REPRESENTATION OF GEOPOTENTIAL BY AREA.

It must of course be understood that a point on the diagram does not represent a unique value of the geopotential. The value depends upon the track which a tracing point has followed in moving from its initial to its final position. Height in the diagram is in fact represented by area and not by a single linear dimension.

$$\text{From the evaluation of geopotential } \Gamma - \Gamma_0 \text{ as } \int \frac{dp}{\rho} \text{ or } \int R t d(\log p)$$

it follows that so long as R can be regarded as constant the change of geopotential is equal to $R \int t d(\log p)$. If we plot a diagram with t and $\log p$ as co-ordinates and consider a strip extending over a vertical $\delta(\log p)$ the increase of geopotential for that strip will be the area enclosed by the element of the curve, the two horizontal lines through its extremities and the zero of temperature.

Similarly on the tephigram a step of geopotential is equal to the area enclosed between the element of the curve the isobaric lines through its extremities and the line of zero temperature.

We thus arrive at the conclusion that on the tephigram the geopotential difference between any two points P and Q is represented

by the area enclosed between the line which represents the portion of the sounding between the two points, the two lines of equal pressure drawn through the two points, and the line of zero temperature.

REPRESENTATION OF WIND-VELOCITY.

In the folio of tephigrams of the specimen volume it has been felt to be desirable to bring in some representation of the wind-velocity derived from the observation of the rising balloon. The representation is difficult because there is no unique line of height. Height is, however, approximately proportional to change in the logarithm of pressure along any straight line. A line at right angles to the isobars would therefore represent height approximately on a linear scale. Again the isobars are so nearly at 45° to the frame that a line at 45° drawn outside the part of the diagram required for the tephigram can be used for a representation of the components of wind at different levels.

The method of representation by components which correspond with what seamen call latitude and departure has considerable advantages over a table in that, without requiring additional space, as many lines can be drawn as there are observations; in fact the more observations there are the better will be the representation, whereas with a table of values the increase in the bulk of figures may hide the salient features.

The heights of the points can be indicated by the corresponding pressures if the pressures are known. If only the heights, or geopotentials, are known it is desirable to set out the intervals on the line corresponding with the changes from sea-level to 1,000 gdm, 1,000 to 2,000 gdm, and so on.

The evaluation however of the selected points of 1,000 gdm, 2,000 gdm, etc., is not easy without some special contrivance, because the answers to the questions imply the selection of points on the curve with equal areas between the lines of equal pressure drawn through them. With a curve that has no recognized geometrical shape the method of trial and error is the only one possible.

The solution can be approached by using the principle that if a line of equal pressure is advanced along the vertical by a millimetre (on a diagram with 1 mm. to a degree), the increase of area is tt square millimetres, and corresponding increase for a diagram of another scale. Moving such a line step by step up the diagram the localities of the selected points could be identified within a fraction of a millimetre.

TABLES FOR CALCULATING THE ENTROPY OF AIR FROM THE MEASURES OF ITS TEMPERATURE AND PRESSURE.

The tables are based upon the formulæ:—

$$dE = c_p \frac{dT}{T}$$

$$\frac{dt}{t} = \frac{\gamma - 1}{\gamma} \frac{dp}{p}$$

integrated between the limits t and T , p and 1,000 mb.;

where E represents entropy in C.G.S. units measured from a zero at 100 tt. and 1,000 mb.

t temperature on the tercentesimal scale ($^{\circ}\text{C} + 273$).

T "megatemperature," potential temperature on the same scale with standard pressure 1,000 mb.

p pressure in millibars.

The formula as developed becomes for entropy and thermal capacity in C.G.S. units:—

$$E = c_p \log_e t/100 - \frac{\gamma - 1}{\gamma} c_p \log_e p/1000.$$

Using the following constants:—

$$\begin{aligned} c_p &= .2417 \times 4.18 \times 10^7 \\ \gamma &= 1.40 \\ \log_e 10 &= 2.30258 \end{aligned}$$

$$\begin{aligned} E &= E(t) + E(p) \\ &= 2.3263 \times 10^7 \log t/100 + .66532 \times 10^7 \log 1000/p \end{aligned}$$

Tables for each of these two terms are given below.

TABLE I. $23.263 \log t/100$.

The figures in the columns give the contribution in millions of C.G.S. units to the Entropy of one gramme of air consequent upon the increase of its temperature at constant pressure from 100 tt to the temperatures indicated in the headings.

| tt | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ | $E(t)$ |
| 300 | 11.099 | 11.133 | 11.166 | 11.200 | 11.233 | 11.266 | 11.299 | 11.332 | 11.365 | 11.398 |
| 290 | 10.757 | 10.791 | 10.826 | 10.861 | 10.895 | 10.929 | 10.964 | 10.998 | 11.032 | 11.066 |
| 280 | 10.402 | 10.438 | 10.474 | 10.510 | 10.546 | 10.581 | 10.617 | 10.652 | 10.687 | 10.722 |
| 270 | 10.035 | 10.072 | 10.109 | 10.146 | 10.183 | 10.220 | 10.257 | 10.293 | 10.330 | 10.366 |
| 260 | 9.653 | 9.692 | 9.731 | 9.770 | 9.808 | 9.846 | 9.884 | 9.922 | 9.960 | 9.997 |
| 250 | 9.257 | 9.298 | 9.338 | 9.378 | 9.418 | 9.457 | 9.497 | 9.536 | 9.576 | 9.615 |
| 240 | 8.845 | 8.887 | 8.929 | 8.970 | 9.012 | 9.053 | 9.094 | 9.135 | 9.176 | 9.217 |
| 230 | 8.415 | 8.459 | 8.502 | 8.546 | 8.589 | 8.632 | 8.675 | 8.718 | 8.760 | 8.803 |
| 220 | 7.966 | 8.012 | 8.057 | 8.103 | 8.148 | 8.193 | 8.238 | 8.282 | 8.327 | 8.371 |
| 210 | 7.496 | 7.544 | 7.592 | 7.639 | 7.686 | 7.734 | 7.780 | 7.827 | 7.874 | 7.920 |
| 200 | 7.003 | 7.053 | 7.103 | 7.153 | 7.203 | 7.252 | 7.302 | 7.350 | 7.399 | 7.448 |
| 190 | 6.485 | 6.538 | 6.590 | 6.643 | 6.695 | 6.747 | 6.799 | 6.850 | 6.901 | 6.952 |
| 180 | 5.938 | 5.994 | 6.050 | 6.105 | 6.161 | 6.215 | 6.270 | 6.324 | 6.378 | 6.431 |

TABLE OF PROPORTIONAL PARTS.

| tt | 0 | .1 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 300 | 0.000 | 0.003 | 0.007 | 0.010 | 0.013 | 0.017 | 0.020 | 0.023 | 0.026 | 0.030 |
| 290 | 0 | 3 | 7 | 10 | 14 | 17 | 20 | 24 | 27 | 31 |
| 280 | 0 | 4 | 7 | 11 | 14 | 18 | 22 | 25 | 29 | 32 |
| 270 | 0 | 4 | 7 | 11 | 15 | 19 | 22 | 26 | 30 | 33 |
| 260 | 0 | 4 | 8 | 11 | 15 | 19 | 23 | 27 | 30 | 34 |
| 250 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 |
| 240 | 0 | 4 | 8 | 12 | 16 | 21 | 25 | 29 | 33 | 37 |
| 230 | 0 | 4 | 9 | 13 | 17 | 22 | 26 | 30 | 34 | 39 |
| 220 | 0 | 5 | 9 | 13 | 18 | 23 | 27 | 32 | 36 | 41 |
| 210 | 0 | 5 | 9 | 14 | 19 | 24 | 28 | 33 | 38 | 42 |
| 200 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 |
| 190 | 0 | 5 | 10 | 16 | 21 | 26 | 31 | 36 | 42 | 47 |
| 180 | 0 | 6 | 11 | 17 | 22 | 27 | 33 | 39 | 44 | 50 |

TABLE II. $E(p) = 6.6532 \log 1000/p$.

The figures in the columns give the contribution, in millions of C.G.S. units, to the Entropy of one gramme of air consequent upon the detente of pressure at constant temperature from 1,000 mb. to the pressure indicated in the headings.

| mb | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ |
| 990 | 0.029 | 0.026 | 0.023 | 0.020 | 0.017 | 0.015 | 0.012 | 0.009 | 0.006 | 0.003 |
| 980 | 0.058 | 0.055 | 0.052 | 0.050 | 0.047 | 0.044 | 0.041 | 0.038 | 0.035 | 0.032 |
| 970 | 0.088 | 0.085 | 0.082 | 0.079 | 0.076 | 0.073 | 0.070 | 0.067 | 0.064 | 0.061 |
| 960 | 0.118 | 0.115 | 0.112 | 0.109 | 0.106 | 0.103 | 0.100 | 0.097 | 0.094 | 0.091 |
| 950 | 0.148 | 0.145 | 0.142 | 0.139 | 0.136 | 0.133 | 0.130 | 0.127 | 0.124 | 0.121 |
| 940 | 0.179 | 0.176 | 0.173 | 0.170 | 0.167 | 0.163 | 0.160 | 0.157 | 0.154 | 0.151 |
| 930 | 0.210 | 0.207 | 0.203 | 0.200 | 0.197 | 0.194 | 0.191 | 0.188 | 0.185 | 0.182 |
| 920 | 0.241 | 0.238 | 0.235 | 0.232 | 0.228 | 0.225 | 0.222 | 0.219 | 0.216 | 0.213 |
| 910 | 0.273 | 0.269 | 0.266 | 0.263 | 0.260 | 0.257 | 0.253 | 0.250 | 0.247 | 0.244 |
| 900 | 0.304 | 0.301 | 0.298 | 0.295 | 0.292 | 0.288 | 0.285 | 0.282 | 0.279 | 0.276 |
| 890 | 0.337 | 0.333 | 0.330 | 0.327 | 0.324 | 0.321 | 0.317 | 0.314 | 0.311 | 0.308 |
| 880 | 0.369 | 0.366 | 0.363 | 0.360 | 0.356 | 0.353 | 0.350 | 0.346 | 0.343 | 0.340 |
| 870 | 0.402 | 0.399 | 0.396 | 0.392 | 0.389 | 0.386 | 0.383 | 0.379 | 0.376 | 0.373 |
| 860 | 0.436 | 0.432 | 0.429 | 0.426 | 0.422 | 0.419 | 0.416 | 0.412 | 0.409 | 0.406 |
| 850 | 0.470 | 0.466 | 0.463 | 0.459 | 0.456 | 0.453 | 0.449 | 0.446 | 0.443 | 0.439 |
| 840 | 0.504 | 0.500 | 0.497 | 0.493 | 0.490 | 0.487 | 0.483 | 0.480 | 0.476 | 0.473 |
| 830 | 0.538 | 0.535 | 0.531 | 0.528 | 0.524 | 0.521 | 0.518 | 0.514 | 0.511 | 0.507 |
| 820 | 0.573 | 0.570 | 0.566 | 0.563 | 0.559 | 0.556 | 0.552 | 0.549 | 0.545 | 0.542 |
| 810 | 0.609 | 0.605 | 0.602 | 0.598 | 0.595 | 0.591 | 0.588 | 0.584 | 0.580 | 0.577 |
| 800 | 0.645 | 0.641 | 0.638 | 0.634 | 0.630 | 0.627 | 0.623 | 0.620 | 0.616 | 0.612 |
| 790 | 0.681 | 0.677 | 0.674 | 0.670 | 0.667 | 0.663 | 0.659 | 0.656 | 0.652 | 0.648 |
| 780 | 0.718 | 0.714 | 0.710 | 0.707 | 0.703 | 0.699 | 0.696 | 0.692 | 0.688 | 0.685 |
| 770 | 0.755 | 0.751 | 0.748 | 0.744 | 0.740 | 0.737 | 0.733 | 0.729 | 0.725 | 0.722 |
| 760 | 0.793 | 0.789 | 0.785 | 0.782 | 0.778 | 0.774 | 0.770 | 0.766 | 0.763 | 0.759 |
| 750 | 0.831 | 0.827 | 0.824 | 0.820 | 0.816 | 0.812 | 0.808 | 0.804 | 0.801 | 0.797 |
| 740 | 0.870 | 0.866 | 0.862 | 0.858 | 0.854 | 0.851 | 0.847 | 0.843 | 0.839 | 0.835 |
| 730 | 0.909 | 0.905 | 0.901 | 0.898 | 0.894 | 0.890 | 0.886 | 0.882 | 0.878 | 0.874 |
| 720 | 0.949 | 0.945 | 0.941 | 0.937 | 0.933 | 0.929 | 0.925 | 0.921 | 0.917 | 0.913 |
| 710 | 0.990 | 0.986 | 0.981 | 0.977 | 0.973 | 0.969 | 0.965 | 0.961 | 0.957 | 0.953 |
| 700 | 1.031 | 1.026 | 1.022 | 1.018 | 1.014 | 1.010 | 1.006 | 1.002 | 0.998 | 0.994 |
| 690 | 1.072 | 1.068 | 1.064 | 1.060 | 1.055 | 1.051 | 1.047 | 1.043 | 1.039 | 1.035 |
| 680 | 1.114 | 1.110 | 1.106 | 1.102 | 1.097 | 1.093 | 1.089 | 1.085 | 1.081 | 1.076 |
| 670 | 1.157 | 1.153 | 1.149 | 1.144 | 1.140 | 1.136 | 1.131 | 1.127 | 1.123 | 1.119 |
| 660 | 1.201 | 1.196 | 1.192 | 1.188 | 1.183 | 1.179 | 1.174 | 1.170 | 1.166 | 1.161 |
| 650 | 1.245 | 1.240 | 1.236 | 1.231 | 1.227 | 1.223 | 1.218 | 1.214 | 1.209 | 1.205 |
| 640 | 1.290 | 1.285 | 1.280 | 1.276 | 1.271 | 1.267 | 1.263 | 1.258 | 1.254 | 1.249 |
| 630 | 1.335 | 1.330 | 1.326 | 1.321 | 1.317 | 1.312 | 1.308 | 1.303 | 1.299 | 1.294 |
| 620 | 1.381 | 1.377 | 1.372 | 1.367 | 1.363 | 1.358 | 1.353 | 1.349 | 1.344 | 1.340 |
| 610 | 1.428 | 1.424 | 1.419 | 1.414 | 1.409 | 1.405 | 1.400 | 1.395 | 1.391 | 1.386 |
| 600 | 1.476 | 1.471 | 1.466 | 1.462 | 1.457 | 1.452 | 1.447 | 1.442 | 1.438 | 1.433 |
| 590 | 1.525 | 1.520 | 1.515 | 1.510 | 1.505 | 1.500 | 1.495 | 1.491 | 1.486 | 1.481 |
| 580 | 1.574 | 1.569 | 1.564 | 1.559 | 1.554 | 1.549 | 1.544 | 1.539 | 1.534 | 1.529 |
| 570 | 1.624 | 1.619 | 1.614 | 1.609 | 1.604 | 1.599 | 1.594 | 1.589 | 1.584 | 1.579 |
| 560 | 1.675 | 1.670 | 1.665 | 1.660 | 1.655 | 1.650 | 1.645 | 1.639 | 1.634 | 1.629 |
| 550 | 1.727 | 1.722 | 1.717 | 1.712 | 1.706 | 1.701 | 1.696 | 1.691 | 1.686 | 1.681 |
| 540 | 1.780 | 1.775 | 1.770 | 1.764 | 1.759 | 1.754 | 1.749 | 1.743 | 1.738 | 1.733 |
| 530 | 1.834 | 1.829 | 1.824 | 1.818 | 1.813 | 1.807 | 1.802 | 1.797 | 1.791 | 1.786 |
| 520 | 1.890 | 1.884 | 1.878 | 1.873 | 1.867 | 1.862 | 1.856 | 1.851 | 1.845 | 1.840 |
| 510 | 1.946 | 1.940 | 1.934 | 1.929 | 1.923 | 1.917 | 1.912 | 1.906 | 1.901 | 1.895 |
| 500 | 2.003 | 1.997 | 1.991 | 1.986 | 1.980 | 1.974 | 1.968 | 1.963 | 1.957 | 1.951 |

TABLE II—(continued). $E(p) = 6.6532 \log 1000/p$.

| mb | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ | $E(p)$ |
| 490 | 2.061 | 2.055 | 2.049 | 2.044 | 2.038 | 2.032 | 2.026 | 2.020 | 2.014 | 2.009 |
| 480 | 2.121 | 2.115 | 2.109 | 2.103 | 2.097 | 2.091 | 2.085 | 2.079 | 2.073 | 2.067 |
| 470 | 2.182 | 2.175 | 2.169 | 2.163 | 2.157 | 2.151 | 2.145 | 2.139 | 2.133 | 2.127 |
| 460 | 2.244 | 2.237 | 2.231 | 2.225 | 2.219 | 2.213 | 2.206 | 2.200 | 2.194 | 2.188 |
| 450 | 2.307 | 2.301 | 2.294 | 2.288 | 2.282 | 2.275 | 2.269 | 2.263 | 2.256 | 2.250 |
| 440 | 2.372 | 2.366 | 2.359 | 2.353 | 2.346 | 2.340 | 2.333 | 2.327 | 2.320 | 2.314 |
| 430 | 2.439 | 2.432 | 2.425 | 2.419 | 2.412 | 2.405 | 2.399 | 2.392 | 2.385 | 2.379 |
| 420 | 2.507 | 2.500 | 2.493 | 2.486 | 2.479 | 2.472 | 2.466 | 2.459 | 2.452 | 2.445 |
| 410 | 2.576 | 2.569 | 2.562 | 2.555 | 2.548 | 2.541 | 2.534 | 2.527 | 2.520 | 2.514 |
| 400 | 2.648 | 2.640 | 2.633 | 2.626 | 2.619 | 2.612 | 2.605 | 2.597 | 2.590 | 2.583 |
| 390 | 2.721 | 2.713 | 2.706 | 2.699 | 2.691 | 2.684 | 2.677 | 2.669 | 2.662 | 2.655 |
| 380 | 2.796 | 2.788 | 2.781 | 2.773 | 2.766 | 2.758 | 2.750 | 2.743 | 2.736 | 2.728 |
| 370 | 2.873 | 2.865 | 2.857 | 2.849 | 2.842 | 2.834 | 2.826 | 2.819 | 2.811 | 2.803 |
| 360 | 2.952 | 2.944 | 2.936 | 2.928 | 2.920 | 2.912 | 2.904 | 2.896 | 2.888 | 2.881 |
| 350 | 3.033 | 3.025 | 3.017 | 3.009 | 3.001 | 2.992 | 2.984 | 2.976 | 2.968 | 2.960 |
| 340 | 3.117 | 3.109 | 3.100 | 3.092 | 3.083 | 3.075 | 3.067 | 3.058 | 3.050 | 3.042 |
| 330 | 3.203 | 3.195 | 3.186 | 3.177 | 3.169 | 3.160 | 3.151 | 3.143 | 3.134 | 3.126 |
| 320 | 3.292 | 3.283 | 3.274 | 3.265 | 3.256 | 3.248 | 3.239 | 3.230 | 3.221 | 3.212 |
| 310 | 3.384 | 3.375 | 3.366 | 3.356 | 3.347 | 3.338 | 3.329 | 3.320 | 3.310 | 3.301 |
| 300 | 3.479 | 3.469 | 3.460 | 3.450 | 3.441 | 3.431 | 3.422 | 3.412 | 3.403 | 3.393 |
| 290 | 3.577 | 3.567 | 3.557 | 3.547 | 3.537 | 3.527 | 3.518 | 3.508 | 3.498 | 3.488 |
| 280 | 3.678 | 3.668 | 3.658 | 3.647 | 3.637 | 3.627 | 3.617 | 3.607 | 3.597 | 3.587 |
| 270 | 3.783 | 3.773 | 3.762 | 3.751 | 3.741 | 3.730 | 3.720 | 3.709 | 3.699 | 3.689 |
| 260 | 3.892 | 3.881 | 3.870 | 3.859 | 3.848 | 3.837 | 3.826 | 3.816 | 3.805 | 3.794 |
| 250 | 4.006 | 3.994 | 3.983 | 3.971 | 3.960 | 3.948 | 3.937 | 3.926 | 3.915 | 3.903 |
| 240 | 4.124 | 4.112 | 4.100 | 4.088 | 4.076 | 4.064 | 4.052 | 4.040 | 4.029 | 4.017 |
| 230 | 4.247 | 4.234 | 4.222 | 4.209 | 4.197 | 4.184 | 4.172 | 4.160 | 4.148 | 4.136 |
| 220 | 4.375 | 4.362 | 4.349 | 4.336 | 4.323 | 4.310 | 4.297 | 4.284 | 4.272 | 4.259 |
| 210 | 4.509 | 4.496 | 4.482 | 4.468 | 4.455 | 4.441 | 4.428 | 4.415 | 4.401 | 4.388 |
| 200 | 4.650 | 4.636 | 4.622 | 4.607 | 4.593 | 4.579 | 4.565 | 4.551 | 4.537 | 4.523 |
| 190 | 4.799 | 4.783 | 4.768 | 4.753 | 4.738 | 4.725 | 4.709 | 4.694 | 4.679 | 4.665 |
| 180 | 4.955 | 4.939 | 4.923 | 4.907 | 4.891 | 4.876 | 4.860 | 4.845 | 4.829 | 4.814 |
| 170 | 5.120 | 5.103 | 5.086 | 5.069 | 5.053 | 5.036 | 5.020 | 5.003 | 4.987 | 4.971 |
| 160 | 5.295 | 5.277 | 5.259 | 5.241 | 5.224 | 5.206 | 5.189 | 5.171 | 5.154 | 5.137 |
| 150 | 5.482 | 5.462 | 5.443 | 5.424 | 5.406 | 5.387 | 5.368 | 5.350 | 5.331 | 5.313 |
| 140 | 5.681 | 5.660 | 5.640 | 5.620 | 5.600 | 5.580 | 5.560 | 5.540 | 5.520 | 5.501 |
| 130 | 5.895 | 5.873 | 5.851 | 5.829 | 5.808 | 5.786 | 5.765 | 5.744 | 5.723 | 5.702 |
| 120 | 6.126 | 6.102 | 6.079 | 6.055 | 6.032 | 6.008 | 5.985 | 5.963 | 5.940 | 5.917 |
| 110 | 6.378 | 6.352 | 6.326 | 6.300 | 6.275 | 6.249 | 6.224 | 6.200 | 6.175 | 6.151 |
| 100 | 6.653 | 6.624 | 6.596 | 6.568 | 6.540 | 6.512 | 6.485 | 6.458 | 6.431 | 6.404 |
| 90 | 6.958 | 6.926 | 6.894 | 6.863 | 6.832 | 6.801 | 6.771 | 6.741 | 6.712 | 6.682 |
| 80 | 7.298 | 7.262 | 7.227 | 7.192 | 7.157 | 7.123 | 7.089 | 7.056 | 7.023 | 6.990 |
| 70 | 7.684 | 7.643 | 7.602 | 7.563 | 7.523 | 7.484 | 7.446 | 7.408 | 7.371 | 7.334 |
| 60 | 8.129 | 8.081 | 8.034 | 7.988 | 7.943 | 7.898 | 7.854 | 7.810 | 7.768 | 7.725 |
| 50 | 8.656 | 8.599 | 8.543 | 8.488 | 8.434 | 8.381 | 8.328 | 8.277 | 8.227 | 8.177 |

Negative changes for pressures higher than 1,000 mb.

| | | | | | | | | | | |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1040 | 0.113 | | | | | | | | | |
| 1030 | 0.085 | 0.088 | 0.091 | 0.094 | 0.097 | 0.100 | 0.102 | 0.105 | 0.108 | 0.111 |
| 1020 | 0.057 | 0.060 | 0.063 | 0.066 | 0.069 | 0.071 | 0.074 | 0.077 | 0.080 | 0.083 |
| 1010 | 0.029 | 0.032 | 0.034 | 0.037 | 0.040 | 0.043 | 0.046 | 0.049 | 0.051 | 0.054 |
| 1000 | 0.000 | 0.003 | 0.006 | 0.008 | 0.011 | 0.014 | 0.017 | 0.020 | 0.023 | 0.026 |

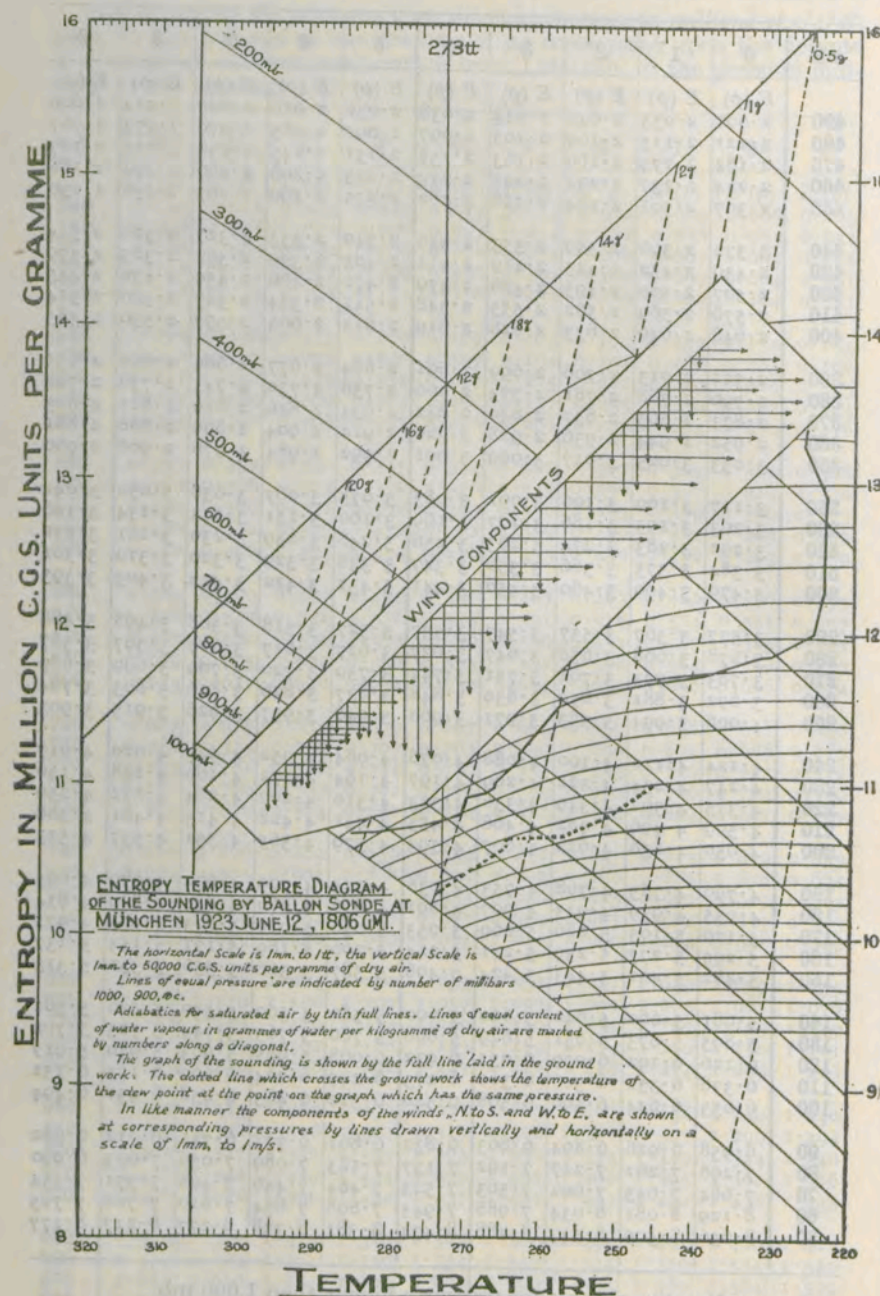


Fig. 1.—Entropy-temperature diagram for a sounding of the upper air with dew-point curve and diagram of the horizontal components of the velocity of the balloon.

(2) Über die Windverhältnisse in der Stratosphäre über München.

VON P. ZISTLER.

Der Untersuchung liegen 50 Registrierballonaufstiege über München zu Grunde mit Visierungen bis 12 km. und mehr. Es ergaben sich folgende Resultate:

Die *Windgeschwindigkeit* nimmt in der Troposphäre mit der Höhe zu, beim Übergang zur Stratosphäre erfolgt zuerst sprunghafte dann langsame Abnahme derselben. Die Erklärung ergibt sich aus der Abminderung des horizontalen Druckgefälles mit dem Eintritt in die Stratosphäre.

Die *Steiggeschwindigkeit* der Ballone nimmt in der Troposphäre mit der Höhe langsam zu, beim Übergang zur Stratosphäre sprunghaft ab und bleibt dann im Wesentlichen konstant. Die Erklärung beruht nach den Wenger'schen Versuchen über Steiggeschwindigkeit von Pilotballonen wohl in der Zunahme der Turbulenz mit steigender Horizontalgeschwindigkeit und plötzlicher Abnahme beim Eintritt in die Stratosphäre.

Die Veränderlichkeit der *Windrichtung* ist naturgemäss am grössten in den unteren Schichten der Troposphäre und nimmt dann rasch ab, beim Übergang zur Stratosphäre nimmt die Veränderlichkeit im Mittel zu, doch zeigt die Durchsicht der Einzelvisierungen, dass dieses Resultat im Wesentlichen durch einige grosse Abweichungen von 90° und mehr zustande kommt; in den weitaus meisten Fällen zeigen sich keine wesentlichen Änderungen beim Passieren der Grenzfläche.

Zwischen der Windrichtung in der Stratosphäre und der Höhenlage der oberen Grenzfläche und damit der *Temperatur* der Stratosphäre ergibt sich nach den 50 Münchener Aufstiegen keine eindeutige Beziehung. Bei allen Windrichtungen treten grosse Schwankungen in der Höhenlage der oberen Grenzfläche und der Temperatur der Stratosphäre auf. Die Annahme, dass Kälteeinbrüche bzw. Druckanstiege aus der Stratosphäre zumeist bei durchgehendem Südwind auftreten, trifft in dieser allgemeinen Fassung nach den Münchener Aufstiegen nicht zu. Es lässt sich an mehreren Beispielen zeigen, dass derartige Kälteeinbrüche auch bei anderen Richtungen auftreten. Nach den 50 Münchener Aufstiegen ist dies bei nördlichen Richtungen sogar häufiger als bei südlichen; doch hat dies seinen Grund darin, dass hohe Visierungen nur bei besonderen Wetterlagen zumeist bei kontinentalem Hochdruck ausgeführt werden konnten; darauf deutet auch die Tatsache hin, dass bei den 50 Aufstiegen die obere Grenzfläche im Mittel ungewöhnlich hoch gelegen war.

Die Erklärung der Kälteeinbrüche in der Stratosphäre durch eine Nordwärtsverlagerung des ganzen äquatorialen Systems bei durchgehendem Südwind muss also eine Ergänzung dahin erfahren, dass analog den Vorgängen bei Polarausbrüchen in den unteren Schichten der Troposphäre auch im Bereiche der Stratosphäre kalte Luftmassen sich von ihrem eigentlichen Entstehungsgebiete lösen, als Kaltlufttropfen nordwärts wandern und gelegentlich wieder nach Süden zurückgeführt werden.

Second Scientific Meeting, Tuesday, 30th August, at 15.30.

Present: Sir Napier Shaw (*President*) in the Chair, Dr. Th. Hesselberg, Mr. R. G. K. Lempfert (*Secretaries*), Dr. Arctowski, Dr. Berson, Prof. V. Bjerknes, Dr. Bruns, Dr. Cannegieter, Dr. la Cour, Prof. Eredia, Dr. E. van Everdingen, Dr. Exner, Dr. Fontseré, Dr. Hergesell, Dr. Keil, Dr. Kölzer, Dr. Linke, Dr. Marczell, Dr. Mariolopoulos, Colonel Meseguer, Dr. Moltchanoff, Dr. Oishi, Dr. Pepler, Dr. Róna, Mons. Schereschewsky, Dr. Schmauss, Sir Gilbert Walker, Dr. Wallén, M. le Capitaine Wehrle, Dr. Weickmann, Dr. Zistler.

(1) (a) Bericht.

Subkommission zum Studium der bei Pilotballon- und bei Registrierballonaufstiegen auftretenden Fragekomplexen.

VON H. HERGESELL.

Der Fragenkomplex, der bei eingehenden Studium aller der Teilfragen in Betracht kommt, die bei Pilot- und Registrierballonaufstiegen in den Vordergrund des Interesses treten, ist sehr gross und in einzelem von Grund aus verschieden. Bearbeitungen und Untersuchungen folgender Teilfragen schienen mir nach Lage der Dinge am meisten geboten:

1. Die Grösse der Steiggeschwindigkeiten von unbelasteten Pilotballonen (für Windmessungen) in der freien Atmosphäre.
2. Die Grösse der Steiggeschwindigkeiten von belasteten grösseren Ballonen, auch Registrierballonen, in der freien Atmosphäre.
3. Einwirkung von Turbulenzonen auf Pilotballone und ihre Steiggeschwindigkeit.
4. Einwirkung von Grenz- und Sperrschichten auf Pilotballone und ihre Steiggeschwindigkeiten.
5. Die Frage nach den geeignetsten Ballonen für Pilot- und Registrierballonzwecke in Bezug auf Fabrikat, Grössen und Gewicht der Ballone.

Ein abschliessendes Urteil kann heute noch nicht vorgelegt werden, da zunächst eine Methodik der Untersuchungen entwickelt und eingehender Kritik unterzogen werden musste.

Auf die grundsätzliche Verschiedenheit der Aufstiegs- werte in Freien gegenüber den in geschlossenen Räumen erhaltenen Werten ist ja schon sowohl von mir ⁽¹⁾ als auch anderen ⁽²⁾ ⁽³⁾ in der Literatur hingewiesen worden. Mit eben der gleichen Berechtigung ist von verschiedenen Instituten die vielfach angestrebte Annahme einer einheitlichen wahrscheinlichsten Aufstiegs- geschwindigkeitsformel abgelehnt worden, da natürlich die Eigenheiten der verschiedensten Ballone, Art des Gummi, Gestalt der Ballone, Dicke der Platten pp. einen wesentlichen Einfluss auf diese Werte haben. Die Frage noch der Möglichkeit der Einführung einer einheitlichen Formel knüpft sich somit eng an die Frage der Verwendung einheitlicher Ballone an.

Eine neue Betrachtungsweise über die Steiggeschwindigkeiten ist vor etwa 10 Jahren auf den Göttinger Windkanalstudien von Professor Prandtl und seinen Schülern über den Luftwiderstand von Kugeln aufgebaut worden. Die Beeinflussung des Luftwiderstandes durch die Turbulenz und die Bedeutung der Reynold'schen Zahl wurden erkannt und ausgenutzt. Die Abnahme des Luftwiderstandes bei Annahme turbulenter Luft und damit die Zunahme der Steiggeschwindigkeit in solchem bewegten Medium sind eine hinreichende Erklärung für die Tatsache, dass alle in der freien Atmosphäre ermittelten Steiggeschwindigkeiten grössere Werte angeben, als die verschiedenen Formeln, die ja aus Beobachtungen in geschlossenen Räumen abgeleitet wurden.

⁽¹⁾ Sixième Réunion de la Commission internationale pour l'aérostation scientifique à Monaco 1909.

⁽²⁾ Wenger, *Annalen der Hydrographie* 1917, S. 121.

⁽³⁾ Hesselberg u. Birkeland, *Annalen der Hydrographie* 1917, S. 313.

Ausser diesen genannten Faktoren können nun in der freien Atmosphäre noch Vertikalbewegungen selbst einen Einfluss auf die Aufstiegs- werte ausüben. Diese Aufzählung mag erhellen mit welcher Vorsicht an die Ausdehnung der Untersuchungen vom geschlossenen Raum auf die freie Atmosphäre gegangen werden muss.

Als Messmittel kommt für Pilotverfolgungen einzig und allein Doppelverfolgung oder Entfernungsmesservisierung des Pilotballons in Frage, während bei den Versuchen mit den grösseren Registrierballonen auch unter gewissen Umständen die barometrisch Höhenbestimmung mit herangezogen werden kann. Bedingung ist und bleibt für den Erhalt einheitlichen Materials aber immer, dass die Ballone einmal in einer einheitlichen Luftmasse während der ganzen Aufstiegs- bestimmung bleiben, dass in der Luftmasse sich die Turbulenz nicht wesentlich mit der Höhe ändert und endlich dass die Reynold'sche Zahl während der für die Bestimmung der Aufstiegs- werte benutzten Zeit keinen ihrer kritischen Werte annimmt. Die Tatsache, dass der kritische Zahlenwert dieser wichtigen Grösse sich mit dem Turbulenz- zustand der Atmosphäre auch noch ändern kann, lässt die Angelegenheit besonders kompliziert werden. Dies muss sich naturgemäss in der Methodik der Bestimmung der Aufstiegs- geschwindigkeit auswirken. Die gewöhnliche Art der Anstellung von Doppelvisierungen, die auf dem Pointieren des Objekts in konstanten Zeitabständen (meistens 1 Minute) beruht ist im grossen und ganzen nicht mehr anwendbar, da auf diese Art nur Mittelwerte erhalten werden, während der genaue Aufstiegs- zustand nicht erfasst werden kann. Am Observatorium Lindenberg ist deshalb dazu übergegangen worden eine halbautomatische Visiermethode einzuführen, die auf der Verwendung photographisch selbstregistrierender Theodolite beruht. Die beiden Beobachter haben hierbei nichts weiter zu tun als dafür zu sorgen, dass das Objekt stets auf dem Fadenkreuz gehalten wird. Von einer Zentralstelle aus wird sodann durch elektrische Kontaktgebung gleichzeitig ein Mechanismus an beiden Instrumenten ausgelöst, der die Kreisablesungen am Instrument photographisch festhält. Damit sind mehrere Vorteile verbunden. Erstens können besonders kritische Punkte der Bahn durch beliebig viele Aufnahmen in kurzen Abständen festgehalten werden, wodurch zweifellos die Genauigkeit der Bestimmung erheblich gesteigert werden kann. Zweitens können bei einundderselben Pilotvisierung die Einflüsse verschiedener Zustände der durchteilten Atmosphäre in ihrem Einfluss auf die Steiggeschwindigkeit des Ballons gleichzeitig erfasst werden. Die gleichzeitige Fixierung des Zeitpunktes der Registrierung auf einen Chronographen sichert weiter die exakte Zeitbestimmung; der letzte Vorteil endlich besteht darin, dass man bei Anwendung drahtloser Auslösung des photographischen Mechanismus die Basis sowohl in Richtung als auch in Länge den jeweiligen Verhältnissen ohne Rücksicht auf örtliche Einflüsse anpassen kann, ohne in der Exaktheit der Messungen irgendwelche Einbusse zu erleiden. Auch die von vielen Seiten angeregte Verfolgung von kleinen Oscillationen in der Ballonbewegung kann durch diese Appa- ratur mit vollkommen ausreichender Genauigkeit geschehen.

Die Zusammenfassung einer so grossen Anzahl von Aufgaben in einer einzigen Messreihe erscheint uns absolut notwendig zu sein, wenn das ganze Problem der Pilot- und Registrierballonaufstiege auch gleichzeitig in Hinblick auf den jeweiligen Zustand der Atmosphäre brauchbares Material liefern soll. Es kommt noch hinzu, dass besonders bei dem Studium des Verhaltens grösserer Ballone die Kostenfrage eine bedeutende Rolle spielt.

Die Auswertung einer Reihe von Vorversuchen, die gelegentlich der Doppelvisierung von Registrierballonen in Lindenberg angestellt werden konnten, hat ergeben, dass die Methode instande ist, ziemlich zuverlässiges einheitliches Material zu liefern. Erleichtert wurde die

Bearbeitung dieses Materials allerdings dadurch, dass nachträglich aus der Darstellung des Registrierergebnisses der Sondierung auf die Realität der aus der Visierung vermuteten Turbulenz—und auch Grenzsichten gute Rückschlüsse möglich waren, ein Umstand, der bei der vielleicht noch wichtigeren Frage der einfachen Pilotballone später allerdings forfallen würde.

Die Frage nach der Festsetzung geeigneter Grössen und sonstiger Fabrikationsdaten für Pilot- und Registrierballone muss m. B. bis zur Erforschung der oben berührten Fragen zurückgestellt werden, da sich sicher in Verlauf der Untersuchungen noch besondere Momente ergeben werden, die einer eingehenden Berücksichtigung in dieser Frage bedürfen. Auch scheint mir die Gummiindustrie im Augenblick noch nicht wieder in der Lage zusein, eine einwandfreie und gleichbleibende Gummiqualität zu liefern. Eine Rundfrage bei den verschiedenen deutschen Instituten und speziell die Erfahrungen am Observatorium Lindenberg zeigen, dass die vor dem Kriege gelieferten Ballone von erheblich gleichmässiger Beschaffenheit waren als die in den letzten Jahren bezogenen Fabrikate. Ob die frühere Gleichmässigkeit wieder erreicht werden kann, wenn den Firmen gewisse Garantien für die Mindestabnahme einer bestimmten Anzahl von Ballonen vorgeschriebener Dimensionen gegeben werden können, muss zunächst dahingestellt bleiben, vor allem solange, bis von Seiten der massgebenden Institute eine Einigung hinsichtlich der Verwendung der verschiedenen Ballongrössen erreicht worden ist.

(b) Die Auswertung spezieller Beobachtungsreihen über die Aufstiegs geschwindigkeit von Gummiballonen.

VON H. HERGESELL.

Infolge des stets wachsenden Interesses an der Ermittlung einer zuverlässigen Korrelation zwischen den Dimensionen von Gummikugelballonen und ihren freien Auftrieb einerseits und der Steiggeschwindigkeit andererseits habe ich Untersuchungen über dieses Problem veranlasst. Eine grössere Anzahl von Doppelvisierungen von Piloten und Registrierballonen, besser gesagt von unbelasteten und belasteten Ballonen sind im Laufe der Zeit bearbeitet worden und mit früheren Ergebnissen verglichen.

Als Resultat dieser Arbeiten kann gesagt werden, dass die schon 1917 von Wenger publizierten Annahmen voll und ganz bestätigt wurden. Der Luftwiderstand, der in erster Annäherung immer gleich der Steigkraft gesetzt worden ist, ist an sich eine derart variable Grösse, dass mit konstanten Verhältnissen kaum gerechnet werden kann. Die starke Turbulenz in der freien Atmosphäre macht alle Annahmen über den Luftwiderstand illusorisch.

Die verschiedenen Ermittlungen, dass die Steiggeschwindigkeit der Ballone bei zunehmender Windstärke ebenfalls zunimmt, findet ebenfalls in dem dabei auftretenden höheren Turbulenzgrad ihre natürliche Erklärung.

Als auffallend möchte ich das Ergebnis bezeichnen, dass die weitaus meisten Ballone, die für Pilotierungen verwendet wurden, in ihrer Dimensionierung unglücklich in Bezug auf die Reynold'sche Zahl gewählt waren. Der bekannte Sprung zwischen $R = 130\,000$ bis $R = 250\,000$ dessen Lage mit dem Turbulenzzustand der Atmosphäre sich noch nach der einen oder der anderen Seite verschieben kann und speziell bei belasteten grösseren Registrierballonen nach unseren Ermittlungen noch mehr in das Gebiet höherer Werte hineinverlegt wird, enthält einen ganz wesentlichen Prozentsatz aller Versuche.

Es ist daher nicht gerade verwunderlich, wenn trotz der grossen Anzahl von Ballonbeobachtungen in den verschiedenen Ländern Verschiedenheiten der Einzelbestimmungen der Steiggeschwindigkeiten untereinander von nahezu 20% und mehr auftreten. Die

Dimensionen der Ballone müssen daher grundlegend revidiert werden, wenn man mit einiger Sicherheit aus denselben auf die Steiggeschwindigkeit schliessen will. Nach Abschluss der im Bericht beschriebenen aufgenommenen Untersuchungen hoffe ich auf der nächsten Tagung positive zahlenmässige Vorschläge machen zu können.

Die Dimensionierung der Ballone günstigster gleichmässiger Aufstiegsverhältnisse wird weiter untersucht werden. Die bisherigen Studien deuten darauf hin, dass alle mittleren Registrierballone von 60–120 cm. Durchmesser in den genannten veränderlichen Sprungbereich der Reynold'schen Zahl fallen. Es müssen daher noch grössere Ballone für diese Zwecke verwendet werden.

(2) (a) Oscillations des ballons-pilotes observées à Barcelone pendant les années 1925, 1926 et 1927 (jusqu' à juillet).

REPORT BY DR. E. FONTSERÉ.

La période moyenne de toutes les observations a été de 2,85 secondes.

La plus courte oscillation régulière observée a été de 2 secondes ; la plus longue de 4 secondes. (Une oscillation enregistrée est toujours la moyenne de 5 oscillations successives.)

La classification des périodes suivant la vitesse ascensionnelle du ballon a donné les résultats moyens suivants :

| | | | | | |
|--|---|-------|-------|---------|------|
| Vitesse ascensionnelle m/s | - | 2 | 2,5 | 3 | 3,5 |
| Période moyenne, sec. | - | 3,11 | 2,98 | 2,81 | 2,67 |
| La classification par poids du globe a donné ces résultats : | | | | | |
| Poids du ballon, g. | - | 55-60 | 85-90 | 100-105 | |
| Période moyenne, sec. | - | 2,77 | 2,94 | 2,88 | |

Les observations à Croydon, Calshot et Shoeburyness ont donné une période comprise entre 2,0 sec. et 2,6 sec. D'après M.J.S. Dines, les oscillations, dans un "air-ship shed," auraient une période de 2 à 2,5 secondes (Meteorological Magazine, nos. 730 et 732 Nov., 1926 and Jan., 1927).

(b) Note by Major Agostinho, Director of the Meteorological Service of the Azores, 18th August, 1927.

"I have tried the observation of the oscillations of short period of pilot-balloons as pointed out by M. Fontseré. The results obtained were as follows :—

| | | |
|------------------------|-----|---------------------------|
| Height 0 to 800 metres | ... | Mean period 1.93 seconds. |
| " 800 to 1,500 " | ... | " " 1.90 " |
| " 1,500 and up " | ... | " " 1.77 " |

(only a few observations available above 1,500 metres).

We only use 9 to 12 grammes weight balloons with 125 metres per minute [2.1 m/s] ascensional velocity. The oscillations were nearly always remarked and their character did not usually change (undulated trajectory)."

(3) The Rate of Ascent of Pilot Balloons for Morning Hours at the Heights of 0.1, 0.5 and 1.0 km. in connection with the Velocity of the Wind.

By P. A. MOLTCHANOFF,

Director, Aerological Observatory, Slutsk (Pavlovsk).

(See Appendix VIII, 3, p. 92.)

(4) Was verlangt die Luftfahrt von der Aerologie und was bietet sie der Forschung?

VON DR. K. KEIL.

Bei der Gründung des deutschen Luftfahrerwarnungsdienstes im Jahre 1910 kamen als wichtige Punkte für eine Warnung vor allem Böen und Gewitter in Frage. Höhenwindmessungen kamen nur insoweit in Frage, als man die Flugrichtung aus ihnen entnehmen konnte. Heute hat sich die Frage dahin geändert, als man vor allem Angaben über die Sicht verlangt, hat man doch sogar gesagt, dass die ganze Wetterberatung heute eine Sichtberatung sei, was meiner Meinung nach allerdings die Aufgabe

des Flugwetterdienstes nur verkleinern heisst. Die Frage aber, was die Aerologie heute der Luftfahrt geben kann, dürfte in diesem Rahmen doch ein gewisses Interesse haben.

Was vermag die Aerologie zu geben?

Einmal sind es Angaben über die Windverhältnisse in der Atmosphäre. Sie werden heute noch wenig benutzt, weil wir nur relativ kurze Strecken zurücklegen. Erst wenn wir Langstreckenflüge haben werden und einen genauen Flugplan werden einhalten müssen, d.h. wenn wir ökonomisch zu fliegen werden gezwungen sein, wird darin eine Änderung eintreten.

Dann kommen Angaben über den Zustand der Atmosphäre in Betracht. Diese werden heute schon vor allem im Winter viel benutzt, um Angaben für die Abdeckung der Kühler der Motoren zu erhalten, die bei warmen Luftmassen über extrem kalten von grosser Bedeutung sein können. Weiter bieten die Angaben von Sperschichten für die Bequemlichkeit eines Fluges eine sehr wesentliche Hilfe, weil über diesen Schichten die Böigkeit verringert wird. Auch für die Lage der Wolkenschichten muss man auf Zustandsmessungen zurückgreifen.

Dann aber leistet die Aerologie für die Erkenntnis der atmosphärischen Vorgänge ganz Wesentliches, haben wir doch erst an Hand der Aerologie die Vorgänge verstehen gelernt, die für uns das Wetter bedeuten. Und wenn die Wetterkunde so ausschlaggebende Unterlagen aus der Aerologie schöpft, so hat auch der Flugwetterdienst sein Teil daran. Eine Flugwetterberatung ohne Aerologie wird mehr und mehr zur Unmöglichkeit.

Auch statistische Angaben aus dem aerologischen Gebiet werden für die Planung und Vorbereitung neuer Fluglinien mehr und mehr herangezogen. Heute haben wir einen Luftverkehr nach dem Prinzip zwei vorhandene Häfen durch eine Fluglinie zu verbinden, später wird sich die Einrichtung von Fluglinien nach dem Bedarf und den günstigsten Flugmöglichkeiten richten.

Endlich aber haben wir damit zu rechnen, dass über kurz oder lang Mitteilungen über die Wetterverhältnisse in der Stratosphäre von uns Aerologen verlangt werden, wenn der Flug in diesen hohen "wolkenfreien" Schichten zur Tatsache wird. Können wir uns heute schon ein Bild über die Veränderlichkeit des Wetters in diesen höchsten Schichten machen? Haben wir das nötige Material z. B. um die Windverhältnisse der Stratosphäre zu kennen? Ich fürchte, man muss sagen, nein! Wir besitzen zwar Visierungen in grosser Zahl—aber alle von Schönwetter lagen. Inwieweit die Methode, die Windverhältnisse aus der Lage des Landungsort zu erschliessen, angewandt werden kann, möchte ich hier nicht näher untersuchen. Jedenfalls liegt hier schon ein Problem, dass der Aerologie über kurz oder lang gestellt werden wird.

Inwieweit Versuche, die in letzter Zeit von französischer Seite gemacht worden sind, Funksender mit Registrierballonen hochzusenden hier einen Fortschritt bedeuten, entzieht sich meiner Kenntnis. Möglich wäre es jedenfalls, durch Peilung solcher Sender die Windrichtungen zu bestimmen—wenn nicht die kurze verwandte Welle eine Peilung vereitelt.

Wir sehen so, dass der Luftverkehr der Aerologie eine ganze Reihe von Aufgaben stellt, was bietet er seinerseits der Forschung? Ich will hier absehen von den regelmässigen Aufstiegen die zu aerologischen Messungen angestellt werden—sie sind nicht Teile des Luftverkehrs. Aber die planmässigen Streckenflüge geben insbesondere durch ihre grosse Zahl, wertvolle Möglichkeiten für den Aerologen, das "Wetter" kennen zu lernen. Nachdem ich mit der Herausgabe der Erfahrungsberichte beauftragt worden war, habe ich mit grossem Vergnügen gesehen, wieviele Einzelheiten von der Kleinstruktur unseres Wetters durch diese Flüge den Meteorologen bekannt geworden sind, die uns immer tiefer in das Verständnis der Zusammenhänge hineinführen.

Der "fliegende Meteorologe" ist heute viel mehr zur Wirklichkeit geworden, als je im Zeitalter der Freiballonfahrten und dass der Luftverkehr den Meteorologen und Aerologen in das Element seiner Tätigkeit hineingeführt hat, das halte ich für eine Förderung der Forschung durch den Luftverkehr.

(5) "Instrument for the investigation of the gustiness of the wind in the free atmosphere and some results of its application." By Dr. P. A. MOLTCHANOFF.

(See Appendix VIII, 4, p. 93.)

(6) The cult of the inversion as a meteorological element.

By Sir Napier Shaw.

In the material contributed by the observers for the international tables of results of registering balloons special note is made of inversions. The position and the amount of the increase of temperature are carefully indicated. More attention is paid to an inversion than to any other feature of the variation of temperature with height.

During the compilation of the tables I have sought to make out whether or not there is any scientific ground for this exceptional treatment. The plotting of the tephigrams which are exhibited in Part IV of the specimen volume affords an exceptionally good opportunity for the study of the question, because both the isothermal line and the adiabatic line for dry air are straight lines, the former vertical, the latter horizontal; and the ground-work of the diagram shows the adiabatic lines for saturated air.

From the point of view of thermal convection there would appear to be no justification for laying special stress on an inversion except the somewhat casual circumstance that in the usual graphs of temperature in relation to height an inversion shows plainly as a movement of the ascending point from left to right of the graph instead of the more common movement from right to left. The eye catches inversions at once; but it does not so easily recognize changes in the slope of the curve which do not include a reversal of right and left. But in spite of its being so conspicuous in the customary diagrams an inversion is not a critical condition for the penetration of the upper layers by the lower layers in thermal convection. There are three critical conditions for penetrative convection, not one of which is easily identified on the conventional diagram.

The first is what W. J. Humphreys calls auto-convection, that is the *bouleversement* of two layers of air in consequence of the lower being lighter than that above. In this case the lapse-rate of temperature may be three or four times the adiabatic rate for dry air before *bouleversement* occurs. This is the condition for certain kinds of mirage.

The second is the ordinary convection of dry air when the ascending air is at higher temperature than its environment, and is pushed upward by the inflow of the environment. The condition for this is that the lapse-rate of the environment shall exceed the adiabatic for dry air. This is shown upon the tephigram by the ascending point of the graph having a downward inclination. A good example is shown in Part IV of the specimen volume in the surface layer for Woodstock on 15th February, 1923. For this occasion the instability may be attributed to the position of the station supplied by cold arctic air but surrounded on all sides by the open water of the lakes not far distant. Many other examples of downward inclination of the tracing point are shown in the collection of tephigrams but they are due mostly to inadequate correction of the pressure. A lapse-rate exceeding the adiabatic is, however, a well-recognized phenomenon and certainly implies the instability of dry air and consequent convection.

The third critical condition is that associated with the convection of saturated air. This cannot be identified at all on the conventional diagram of temperature in relation to height. The tephigram is provided with a family of adiabatics for saturated air, which can be used for identifying the positions of instability of saturated air in the environment represented by the curve. Convection will occur wherever the ascending tracing-point leaves the curve of environment on its right. The most striking examples among the diagrams of Part IV of the specimen volume are Pavia, on 12th February, and 6th April; Benson and München on 3rd

May; and Benson on 5th July, 1923. The two examples from Benson represented the condition of the atmosphere before thunderstorms, that for 6th July was four days before an extraordinarily violent storm in England.

If air is stable for saturated air, it is more definitely stable for dry air and still further removed from the possibility of auto-convexion. The three lines on the tephigram indicating these conditions are: (1) the adiabatic for saturated air, (2) the adiabatic for dry air which is horizontal and the auto-convexion line along which p/tt is constant, or for small variation dp/dtt is constant.

It would appear, therefore, that the most critical condition for thermal convexion at any point in the atmosphere, namely, that for saturated air, is when the adiabatic for saturated air passing through the point on the upward line leaves the curve of environment on its right, or is drawn at a greater angle with the horizontal than the curve of environment. The curves of the adiabatics of saturated air are obviously at different angles with the horizontal at different parts of the diagram. The steepest inclination is about 60° . Consequently we may generalize the condition for stability by saying that there will be no convexion at any point of a tephigram if the line of the curve at that point is inclined to the horizontal at an angle greater than 60° . That degree of steepness is only required at the higher temperatures. Below the freezing-point an inclination of 45° would be sufficient security against convexion.

But the isothermal line which is the critical line for identifying an inversion is already at an angle of 90° to the horizontal, the line of an inversion is at an angle greater than 90° .

From the point of view of thermal convexion, therefore, an isothermal line or an inversion does not mark a critical condition, it simply marks one stage in the gradual increase of stability from that which will just retain saturated air without convexion to the unlimited stability of temperature increasing rapidly with height. And equally from that point of view the special attention paid to inversions is unaccountable.

There is another point of view; an increase of temperature with height though frequent enough above any chilled surface is not a normal condition of the upper layers of the free air. It is, however, not of infrequent occurrence. The folio of tephigrams of the specimen volume presents examples in addition to the inevitable occurrences of the stratosphere:—at Benson, on 12th February; Trappes and de Bilt, on 15th February; Benson, 16th February; München, 17th February; Benson, 3rd March; and a few others which need not now be enumerated. The example of Benson, on 3rd March, will serve our purpose. There is evidently a stratification of the troposphere into two layers, the upper layer with much greater entropy (potentially much warmer) than the lower one.

The origin of this dual stratification of the stratosphere is an important and interesting question, and in so far as an inversion is an indication of such stratification its cult is justified.

The ease with which the stratification can be recognized on the tephigram as well as all three criteria of convexion, saturated air, dry air and auto-convexion, represent some of the advantages of that type of diagram

Third Scientific Meeting, Thursday, 1st September, 1927,
at 15.30.

Present: Sir Napier Shaw (*President*) in the Chair, Mr. R. G. K. Lempfert (*Secretary*), Dr. Alt, Dr. H. G. Cannegieter, Dr. D. la Cour, Prof. F. Eredia, Dr. E. van Everdingen, Dr. Exner, Dr. Fontseré, Dr. Hergesell, Dr. Keil, Dr. Kimball, Dr. Kölzer, Dr. Linke, Dr. Marczell, Dr. Moltchanoff, Dr. Oishi, Dr. L. F. Richardson, Dr. Róna, Dr. Schmauss, Mons. Ph. Schereschewsky, Mons. le Capitaine Wehrle, Dr. Weickmann, Dr. Zistler.

The following papers were read:—

(1) **Apparatus for transmitting a Recorder's Readings at a Distance.**

(Appendix VIII, 1. p. 91)

By DR. P. MOLTCHANOFF.

Dr. Kimball said that he had available some diagrams handed to him by Dr. Gregg, Chief of the Aerological Division of the Weather Bureau, showing the arrangement of the circuits in use in the Weather Bureau for transmitting observer's records from the roof to the computers in the building below. The diagrams were available for inspection by any members of the Commission who were interested. The general principle of the arrangement is that a clock starts as soon as the balloon is released and this gives signals to the observer every minute. The observer's readings are transmitted by telephone to the computers below; and the computation is completed by the time the ascent is over.

(2) **On fitting a hygrograph to the standard Dines baro-thermograph.**

By L. H. G. DINES.

It has been a common ground of objection to the use of the Dines pattern of balloon meteorograph that it was not capable of giving a record of the relative humidity. Experiments in that direction were made by Mr. W. H. Dines many years ago, but though they were partly successful they were not followed up to such a complete conclusion as would have enabled a hair hygrometer to be fitted to the instrument as a regular procedure, and give results which could be readily interpreted.

Working on somewhat the same lines as Mr. W. H. Dines, I have recently developed a detachable hair hygrometer for use with the standard form of Dines baro-thermograph.

It is not as easy to fit a hygrometer to a simple baro-thermograph as it is to a meteorograph of the usual type where a clock and drum are employed and the synchronization of the pressure-temperature record and the pressure-humidity record is a point which calls for a great deal of care. The addition of a record of humidity undoubtedly greatly increases the value of the complete record, but to attain adequate accuracy in the final figures the amount of work involved in preparing for a sounding and computing the results is enormously increased.

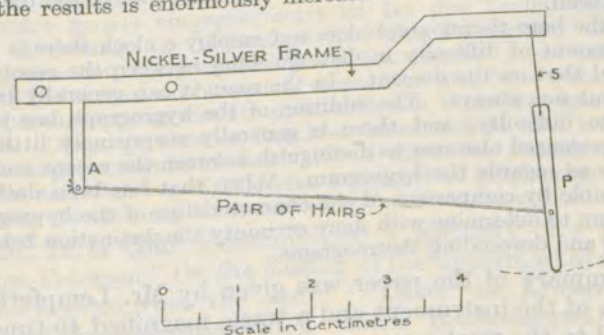


FIG. 2.

The hygrometer which has been used during the last nine months at Kew Observatory, is shown in Figure 2. Human hairs are employed of a mean diameter of about $\cdot 08$ mm. a pair being employed instead of a bundle. The flat spring S provides that the load on the hairs under working conditions

shall be about 2 grammes per hair, and serves at the same time as a hinge about which the arm A and scribing point P rotate, so that no slackness nor backlash can occur. The hairs are calibrated by removing the hygrograph attachment from the baro-thermograph and placing it on a suitable frame in a chamber through which a continuous current of air is drawn by means of a fan. The composition of the air can be varied at will by passing it through a box filled with ice and then over a heater, or alternatively through a closed vessel containing warm water. Values of the relative humidity as low as 20 per cent. or as high as about 95 per cent. can be easily obtained in this way; a two-way valve allows of any combination of the two extremes. The vapour pressure of the air is determined by drawing it through an Assmann psychrometer in series with the chamber. A thermometer placed inside the chamber and close to the hairs under test allows of the determination of the relative humidity of the air at the moment when it passes the hairs. The scribing point makes marks on a small record plate exactly similar to that employed in the baro-thermograph, and subsequent examination under a microscope enables the movement of the point corresponding with the various degrees of relative humidity to be determined. To obtain the saturation line the hygrograph on its frame is immersed in a water bath.

When it is intended to fit a hygrograph to a baro-thermograph the latter is calibrated for pressure-temperatures at temperatures below the freezing point before the hygrograph is attached to it. The hygrograph is then attached and finally the whole instrument is immersed in a water bath and such further pressure-temperature marks made as may be desired, the latter process providing in addition both the saturation line of the hygrograph and the necessary material for the subsequent synchronization of the two records.

It is necessary to attach the hygrograph to the frame of the baro-thermograph in such a manner that (1) The two records shall be visible at one and the same time in the field of view of the reading microscope. (2) The virtual radii of the two scribing point arms shall be parallel to each other under mean conditions of humidity and temperature. If these two conditions are not fulfilled the tabulation of the hyrogram in relation to the thermogram becomes very difficult.

About a dozen records have so far been obtained with instruments of the type under discussion, and on the whole the results are encouraging. It would not be true to say that all difficulties have been overcome, and the use of hair for the recording of relative humidity has well known limitations; on the other hand the progress made warrants the hope that when more experience has been gained the recording of the relative humidity will, within those limits, become as straightforward as that of the temperature has long been.

Since the baro-thermograph does not employ a clock there is always a certain amount of difficulty in distinguishing between the record on the ascent and that on the descent. In the main it can generally be accomplished, but not always. The addition of the hygrograph has tended to reduce the difficulty, and there is generally surprisingly little trouble for an experienced observer to distinguish between the ascent and descent separately as regards the hyrogram. When that has been decided it is often possible by comparison of the characteristics of the hyrogram and thermogram to determine with more certainty the distinction between the ascending and descending thermograms.

A summary of the paper was given by Mr. Lempfert, and a specimen of the instrument and a trace, magnified 40 times, were exhibited to the meeting.

(3) **Dr. E. van Everdingen** gave an account forwarded by Dr. Nell of an apparatus of Mr. T. D. Carley,

"L'appareil serait capable d'enregistrer pression, température, humidité, direction et vitesse du vent jusqu'à une hauteur de 5,000 m.

HAURWITZ—RELATION BETWEEN CHANGES OF PRESSURE AND TEMPERATURE.

et tout cela dans tous les conditions atmosphériques. La durée de l'ascension serait assez petite et les résultats immédiatement à disposition. Les frais des ascensions seraient au-dessous de ceux par des ascensions en aéroplans." Prix estimé fr. 30,000.

(4) Beziehungen zwischen Luftdruck- und Temperaturänderungen.

Ein Beitrag zur Frage des "Sitzes" der Luftdruck-schwankungen.

VON B. HAURWITZ IN LEIPZIG.

Schedler fand, dass die Temperaturänderungen der untersten 9 km. im Durchschnitt fast gar keinen Beitrag zur Bodendruckänderung geben, dass die unterste Stratosphäre etwa die Hälfte zur Bodendruckänderung beitrage und der Rest von Vorgängen in höheren Schichten herrühre. Es ist aber bekannt, dass im Einzelfalle, besonders bei grossen Druck- und Temperaturänderungen die Verhältnisse meist wesentlich einfacher liegen.

Zur statistischen Untersuchung dieser Frage wurden die internationalen Ballonaufstiege benützt. Je zwei im Zeitraum von 24 Stunden aufeinanderfolgende Aufstiege wurden zu einem Paar vereinigt (insgesamt 328 Paare) und die interdiurnen Änderungen von Druck und Temperatur berechnet.

Fasst man alle einander zugeordneten Werte der interdiurnen Änderung von Druck, Temperatur und thermischem Einfluss $\left(-P \frac{g}{R} h \frac{\Delta T}{T^2}\right)$

ohne Rücksicht auf das Vorzeichen zusammen, so erhält man ähnliche Resultate wie Schedler aus viermal kleinerem Material. Die grössten Beträge von Temperaturänderung und thermischem Einfluss finden sich in der untersten Stratosphäre.

Zur genaueren Untersuchung wurden die Paare gruppiert erstens nach den Vorgängen an der Stratosphärenengrenze, je nachdem, ob sie sich hob oder senkte, und ob die Temperatur an dieser Grenze zu- oder abnahm, zweitens nach den Vorgängen am Boden, je nachdem hier Druck und Temperatur zunahm oder fielen. In diesem Falle nimmt die interdiurne Druckveränderlichkeit mit der Höhe schnell ab bei den beiden Gruppen, bei welchen Bodendruck- und temperaturänderungen entgegengesetztes Vorzeichen haben, bei den zwei anderen Gruppen ist die interdiurne Druckänderung in der ganzen Troposphäre von nahezu gleichem Betrage. Das stimmt mit den Folgerungen aus der barometrischen Höhenformel überein.

Bei Gruppierung nach den Vorgängen an der Stratosphärenengrenze zeigt sich, dass das Vorzeichen der Temperaturänderung in Tropo- und Stratosphäre gerade entgegengesetzt ist bei den beiden Gruppen, bei welchen Änderung der Höhenlage und der Temperatur der Stratosphärenengrenze entgegengesetztes Vorzeichen haben. Diese auffällige Erscheinung findet man auch wieder, wenn man die Paare jeder einzelnen Stratosphärengruppe in vier Gruppen nach den Veränderungen am Boden unterteilt. Die so gefundenen Resultate lassen sich in einer interessanten Vorzeichenregel zusammenfassen. Die synoptische Bearbeitung zweier Einzelfälle nach den von V. Bjerknes entwickelten graphischen Methoden brachte eine Bestätigung der statistisch gefundenen Resultate.

(5) **Dr. D. la Cour** communicated a summary of a paper by Dr. Helge-Petersen "On the heating of the uppermost atmosphere by cathode-rays from the sun" ("Ueber die Erwärmung der höchsten Atmosphärenschichten durch Kathodenstrahlen von der Sonne"), which had recently been published in English by the Danish Institute and in German in *Phys. Zs. Jg. 28, 14 S. 510 bis 513.*

A discussion followed in which Dr. Schmauss, Dr. Hergesell, Dr. E. van Everdingen, Dr. la Cour and the President took part.

Dr. Schmauss suggested that observations on the propagation of sound from explosions might throw further light on the questions involved and suggested that the Commission might pass a resolution urging the desirability of organizing such work.

Dr. Hergesell supported this proposal and expressed a desire also to have the area of operations extended to include the equatorial regions. He pointed out that the number of balloon observations from Arctic regions is very small and reminded the meeting of the ascent he had made from Spitzbergen, in which the stratosphere had not been found at the expected low level. Some years ago, in connexion with the Zeppelin expedition he had drawn attention to the proposal to make ascents of registering balloons from the upper platform of the Airship—a method which M. Molchanoff had also advocated.

A resolution proposed by Dr. Schmauss was submitted at the business meeting on Friday morning (*See p. 37*).

(6) **Prof. Eredia**, at the close of the meeting, read the following statement giving a brief account of the new organization of aerological work in Italy, which had recently come into being.

Avant tout, je vous prie de vouloir bien me permettre d'exprimer à Monsieur le Président l'assurance de mes sentiments bien dévoués. Ensuite, je désire, chers collègues, vous expliquer les questions que j'ai eu l'honneur de vous signaler hier.

Tout d'abord, je vous donnerai des renseignements sur l'organisation des services aérologiques en Italie lesquels se sont transformés dans le courant de l'année passée. Comme vous savez, auparavant, il y avait en Italie deux Instituts qui s'occupaient d'observations aérologiques, à savoir le bureau central de météorologie et géophysique par des observations régulières qui avaient lieu et ont encore lieu présentement à Pavia et par des observations extraordinaires accomplies par le Professeur Palazzo dans ses explorations et par moi-même sur l'Etna. Il y avait en outre le service aérologique qui s'occupait du fonctionnement des stations aérologiques et de la publication des observations sur le bulletin quotidien.

Or, en vertu d'une disposition récente du gouvernement national, le service des prévisions vient d'être dégagé par un bureau spécial de prévisions qui dépend du ministère de l'aéronautique royale. Par cette réforme on a obtenu une unification convenable des services chargés de la prévision du temps en Italie et maintenant l'opportunité s'est révélée de publier un bulletin unique.

Dès le 1^{er} Avril, ce bulletin unique fut envoyé aux Instituts, aux Académies et à toutes les personnes qui avaient reçu jusqu'alors l'un ou l'autre des deux bulletins.

Les observatoires demeureront comme par le passé en rapport avec le Bureau Central de Météorologie et Géophysique pour toutes les observations météorologiques en général tandis qu'ils s'adresseront directement au bureau des prévisions seulement pour tout ce qui se rapporte aux observations pour les cartes synoptiques, c'est à dire les observations qui seront envoyées télégraphiquement, de sorte que nous avons maintenant en Italie un seul Institut chargé des prévisions générales du temps et des observations aérologiques.

Seul l'Observatoire Royal Géophysique de Pavia reste encore isolé. C'est là que le professeur Gamba, avec tous les moyens donnés par le Bureau Central Royal de Météorologie et en partie même par le Bureau de Prévision, développe une admirable activité avec le lancement des ballons-sondes.

La première question que j'ai eu l'honneur de vous exposer concerne la publication du volume de l'année 1923. Ce volume, contient pour

l'Italie spécialement les observations faites à l'Observatoire de Pavia et pour cela, les demandes sur les contributions financières devront être envoyées directement à M. le Professeur Palazzo.

A l'avenir ce sera un peu différent parceque les observations italiennes seront plus nombreuses.

Dans l'année 1926, la station principale aérologique de Vigna di Valle qui est sous la dépendance directe du Bureau des Prévisions a montré un regain d'activité.

De plus, tous les jours on fait à Vigna di Valle des sondages avec des ballons captifs, et, quand les conditions du vent le permettent, avec des cerfs-volants.

C'est mon intention de porter rapidement (le plus vite possible) à la connaissance des savants les observations aérologiques qui seront faites peu à peu.

J'ai l'honneur de présenter le volume contenant les lancements accomplis en Italie pendant l'année 1926 dans les jours choisis pour la Présidence de cette Commission.

D'autres volumes suivront les années suivantes. Ils seront destinés à former la collection complète de tous les sondages Italiens en concomitance avec ceux accomplis dans les autres nations.

Je suis heureux de communiquer que la synthèse de toutes les observations recueillies au cours des années passées a été commencée. Le plus tôt possible, seront publiés : le volume se rapportant à la station de Vigna di Valle qui a été préparé par moi, personnellement, puis, successivement les volumes relatifs aux autres stations aérologiques.

Toutes les observations aérologiques italiennes faites seront envoyées à la fin de chaque mois à la Présidence pour les publications internationales. A ce propos, j'exprime seulement le désir que les frais de ces publications internationales soient mieux repartis. Et je pense que la contribution italienne du Bureau de Prévision du temps serait la plus favorable si la Commission décide d'examiner la question de la langue officielle pour les discussions des années à venir et aussi pour les publications officielles.

Je me permets de vous représenter l'utilité pratique qu'il y aurait à employer deux langues différentes. Sans doute, tous les savants peuvent comprendre les procès verbaux écrits dans les langues les plus communes comme l'anglais, l'allemand et le français, mais il est nécessaire que les travaux des commissions parviennent à la connaissance parfaite de chaque collègue.

Je pense que les recherches scientifiques et surtout celles de la haute atmosphère devront s'intensifier comme recherches internationales parcequ'elles regardent la terre entière où la civilisation s'est affirmée, et par le concours financier plus direct des différents Instituts. Les savants de tous les pays sont unis dans un seul idéal toutes les fois qu'il s'agit d'une entreprise qu'a pour but la connaissance plus parfaite des phénomènes naturels.

He stated that in future all Italian aerological observations would be sent to the President at the end of each month for incorporation in the international publication. He expressed the hope that the cost of production of the latter would be widely distributed, and asked that the Commission should give attention to the question of the choice of the language in which future editions would be prepared. He suggested that it might be desirable to print the text in two languages.

The meeting adjourned at 5.30 p.m.

APPENDIX I.

FINANCIAL STATEMENT (1st April, 1925, to 31st October, 1927).

Specimen Volume for 1923.

Receipts.

Netherlands Institute, 1923
 Director, Aeronautical Observatory, Lindenberg
 Leningrad Geophysical Observatory
 International Union for Geodesy and Geophysics
 Advance to be recovered by the disposal of copies up to 250
 14 copies have already been sold on this account.

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APPENDIX I.—continued.

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| 82 | 6 | 8 |

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| 41 | 6 | 0 |
| £41 | 6 | 0 |

APPENDIX II.

Données reçues par le Bureau depuis la réunion de la Commission en avril 1925 jusqu'à juin 1927.

(y - inclus les données envoyées par M. le Dr. Th. Hesselberg pour les années antérieures à 1925.)

Observations are regularly received in the form of printed reports from Rio de Janeiro (Dr. Sampaio Ferraz) and reports have also been received from the Argentine explaining the reorganization of the meteorological service and from G. W. Cox, Meteorological Office, Pretoria.

REGION C.

Avant 1921.

Allemagne : (Lindenberg) Die Arbeiten des Preuss. Aeronaut. Obs. bei Lindenberg. XV Band. Observations de ballon-sondes 1915, 1917, 1921.

Açores : Observations de nuages 1919 et 1920.

Espagne : (Catalunya) Observations de ballons-pilotes 1916-20. (Notes d'Estudi Nos. 14 et 19).

Norvège : Observations de ballons-pilotes à l'Aas et Bergen 1920. Observations de nuages à six stations en 1920.

Russie : (U.S.S.R.) Observations de ballons-sondes, ballons-pilotes, et cerf-volants en 1913.

REGION C.

1921.

Açores : Observations de nuages, janvier-mars.

Espagne : (Catalunya) Observations de ballons-pilotes, septembre-décembre. (Notes d'Estudi No. 12.)

Norvège : Observations de ballons-pilotes, Bergen, avril-septembre ; Aas, mars-novembre. Observations de nuages à quatre stations, janvier-décembre.

Russie : (U.S.S.R.) Observations de ballons-pilotes à trois stations, avril à décembre.

REGION D.

Chine : (Hong Kong) Observations de ballons-pilotes, juin-septembre.

REGION C.

1922.

Açores : Observations de ballons-pilotes et de nuages des jours internationaux, mai-décembre, avec des observations additionnelles de février-août. Résumé d'observations, 1922.

Allemagne : (München) "Die Münchener Registrierballonfahrten." (Cuxhaven) Obsns. de ballons-pilotes et de cerfs-volants, septembre.

Bulgarie : Observations de nuages, janvier et avril.

Egypte : Observations de ballons-pilotes, janvier, mai, septembre.

Espagne : (Catalunya) Observations de ballons-pilotes, janvier-décembre. (Notes d'Estudi, Nos. 12 et 22.)

Finlande : Observations de ballons-pilotes, janvier et mai.

France : (Trappes) "Lancers de ballons-sondes de 1922." Observations mai, septembre, octobre.

REGION C.—continued

(Strasbourg) Observations de ballons-sondes et de ballons-pilotes, janvier, mai, septembre et octobre. L'extrait de l'annuaire de l'institut de physique du globe.

Islande : Observations de ballons-pilotes à Reykjavik, janvier et mai.

Italie : Observations de ballons-pilotes à l'environ de sept stations, avril-décembre. "Bollettino Aerologico" avril 1-juin 30.

Norvège : Observations de ballons-pilotes à Bergen, avril-octobre, et à l'Aas, mars-octobre. Observations de nuages à quatre stations.

Russie : (U.S.S.R.) Observations de ballons-pilotes, avions, cerfs-volants et nuages, janvier, mai, septembre.

Tchéco-Slovaquie : Observations de nuages et de stations de montagne, janvier.

REGION D.

Ceylan : Observations de ballons-pilotes, mai et septembre. "Upper Air Observations, 1922-23," Bulletin of Colombo Observatory.

Chine : (Hong Kong) Observations de ballons-pilotes, mai-décembre.

REGION E.

Afrique du sud : Observations de ballons-sondes et de ballons-pilotes mai.

1923.

REGION A.

Etats Unis : Observations de cerfs-volants aux jours internationaux à six stations.

REGION B.

Pérou : Observations de la station de montagne, Arequipa.

REGION C.

Açores : Observations de ballons-pilotes et de nuages, janvier-décembre.

"Résumé d'Observations, 1923."

Allemagne : (Lindenberg) "Die Arbeiten des Preuss. Aeronaut. Obs. bei Lindenberg. XV Band." Observations de cerf-volants et de ballons-pilotes.

(München) "Die Münchener Registrierballonfahrten."

Bulgarie : Observations de nuages, janvier-décembre.

Egypte : Observations de ballons-pilotes, janvier-décembre.

Espagne : (Catalunya) Observations de ballons-pilotes, janvier-décembre. (Notes d'Estudi, Nos. 25 et 28.)

(Madrid et les autres stations) Observations de ballons-sondes (téphigrammes) et de ballons-pilotes, février, juin et octobre.

(Tortosa) Observations de ballons-pilotes, juin.

France : (Trappes) Observations de ballons-sondes (et téphigrammes) janvier-décembre.

Grande Bretagne : Observations de ballons-sondes.

Italie : Observations de ballons-pilotes à l'environ de six ou sept stations, janvier-octobre, et décembre.

(Pavia) Observations de ballons-sondes.

Norvège : Observations de ballons-pilotes à Bergen, février avril, juin, octobre et novembre, et à l'Aas, avril-juillet, septembre-décembre.

Observations de nuages à quatre stations, janvier-décembre.

Russie (U.S.S.R.) Observations de ballons-sondes, cerfs-volants, avions, ballons-pilotes et de nuages, juillet-décembre.

REGION D.

Ceylan : Observations de ballon-pilotes et de nuages, février, juin et octobre.

"Upper Air Observations, 1922-23," Bulletin of the Colombo Observatory.

Chine : (*Hong Kong*) Observations de ballons-pilotes, février, mars, mai et décembre.

REGION E.

Afrique du sud : Observations de ballons-pilotes à Pretoria, février, mai et novembre.

REGION F.

Australie : Observations de ballons-pilotes et de nuages à Melbourne et Willis Island, janvier et décembre.

Samoa : (*Apia*) Observations de ballons-pilotes, juin. "Upper Air Observations, 1923-24."

1924.

REGION B.

Pérou : Observations de la station de montagne, Arequipa.

REGION C.

Allemagne : (*Lindenberg*) "Kurzer Monatsbericht" observations de cerfs-volants janvier-décembre.

"Die Arbeiten des Preuss. Aernaut. Observatoriums bei Lindenberg," XV Bd. observations de ballons-sondes.

(*München*) "Die Münchener Registrierballonfahrten."

Autriche : (*Wien*) Liste des dates des observations de ballons-sondes, mars, juillet, septembre, novembre.

Açores : Observations de ballons-pilotes et de nuages, janvier-décembre.

Bulgarie : Observations de nuages, janvier-avril, et juin-décembre.

Egypte : Observations de ballons-pilotes, janvier-décembre.

Espagne : (*Catalunya*) Observations de ballons-pilotes, janvier-décembre. (Notes d'Estudi, Nos. 31 et 33.)

(*Madrid*) Observations de ballons-sondes (téphigrammes), et observations de ballons-pilotes à l'environ de 10 stations, mars, juillet, septembre et novembre.

France : (*Trappes, Angoulême et Lyon*) Observations de ballons-sondes (téphigrammes), janvier-décembre.

(*Strasbourg*) Observations de ballons-sondes et de ballons-pilotes. Extrait de l'annuaire de l'institut de physique du globe.

Grande Bretagne : Observations de ballons-sondes des jours internationaux.

Téphigrammes de cinq ascensions de ballons-sondes, le 4 septembre.

Italie : Observations de ballon-pilotes à l'environ de six ou huit stations, janvier-novembre.

(*Pavia*) Observations de ballons-sondes, janvier-décembre.

Norvège : Observations d'avions et de nuages à Kjeller, juillet et août. Observations de ballons-pilotes à Bergen, mars-décembre, et à l'Aas, février-décembre.

Observations de nuages à 3-5 stations, janvier-décembre.

Roumanie : Observations de ballons-pilotes, janvier.

Russie : (U.S.S.R.) Observations d'avions, cerf-volants, ballons-pilotes et nuages, janvier-décembre. Observations de ballons-sondes, cerfs-volants et ballons-pilotes et nuages, mars, juillet, septembre, novembre. Observations de ballons-pilotes, des jours internationaux.

Liste des observations de ballons-pilotes à 33 stations.

REGION C.—continued.

Suisse : Observations de stations de montagne. Auszug aus den "Annalen der Schweizerischen meteorologischen Zentral-Anstalt."

Tchéco-Slovaquie : Observations de montagne (*Donnersberg*) septembre.

REGION D.

Ceylan : Observations de ballons-pilotes et de nuages, mars, juillet et novembre.

Chine : (*Hong Kong*) Observations de ballons-pilotes, janvier-novembre.

REGION E.

Afrique du sud : Observations de ballons-pilotes à Pretoria, mars-novembre.

REGION F.

Australie : Observations de ballons-pilotes à Melbourne et Willis Island, janvier à décembre.

Samoa (Apia) : "Upper Air Observations 1923-24," observations de ballon-pilotes.

REGION J.

Japan (Tateno) : "Raporto de la Aerologia Observatorio de Tateno, No. 1," observations de ballons-pilotes.

1925.

REGION A.

Mexique : Observations de ballons-pilotes, août.

REGION C.

Allemagne : (*Lindenberg*) "Kurzer Monatsbericht." Observations de cerfs-volants, avril-décembre. "Die Arbeiten des Preuss. Aeronaut. Obs. bei Lindenberg" XV Bd, observations de ballons-sondes.

Autriche : (*Wien*) Données sur la date des ascensions de ballons-sondes, janvier, avril, août, décembre.

Açores : Observations de ballons-pilotes et de nuages, juillet-décembre.

Bulgarie : Observations de nuages, janvier-décembre.

Egypte : Observations de ballons-pilotes, janvier-décembre.

Espagne : (*Catalunya*) Observations de ballons-pilotes et de nuages, août.

Observations de ballons-pilotes, janvier-décembre. (Notas de Estudio No. 33.)

(*Tortosa*) Observations de ballons-pilotes, avril-décembre.

France : (*Trappes*) Observations de ballons-sondes (téphigrammes), janvier, février, avril, mai, juin, août, septembre, octobre, novembre et décembre.

(*Strasbourg*) Observations de ballons-sondes et de ballons-pilotes. Extrait de l'Annuaire de l'Institut de physique du globe.

Grande Bretagne : Observations de ballons-sondes, le 24 janvier (et téphigramme), et à l'occasion de la réunion de la Commission en avril.

Observations de ballons-pilotes à Cranwell, août.

Hollande : Observations de ballons-sondes et d'avions aux jours internationaux. De Bilt, De Kooij et Soesterberg. Observations de ballons-pilotes, mai, août.

REGION C.—continued

Italie : Observations de ballons-pilotes, à l'environ de six stations, janvier, mars-décembre.

(*Pavia*) Observations de ballons-sondes mars-décembre et de ballons-pilotes, janvier-décembre.

Norvège : Observations de ballons-pilotes à Bergen, avril-décembre et à l'Aas, mars-novembre.

Observations de nuages à trois ou quatre stations, janvier-décembre.

Russie (U.S.S.R.) : (*Sloutzk et Leningrad*) Bulletin quotidien, juillet, août, septembre 1-15, octobre-décembre. "Meteorological Review," janvier-septembre. Observations de ballons-sondes, (et téphigrammes), cerfs-volants, avions et ballons-pilotes, janvier, avril, août et décembre. Observation d'un ballon-sonde à Sverdlovsk (Ekaterinbourg) le 21 août.

(*Moscow*) "Etudes scientifiques de l'atmosphère, Fascicule IV observations de ballons-pilotes. Ukrainian Meteorological Service "Geophysical Characteristic of Ukraine, 1925, Part II, Upper Air Observations." Observations de ballons-pilotes.

Suisse : Observations de stations de montagne. Auszug aus den Annalen der Schweizerischen meteorologischen Zentral-Anstalt.

Tchéco-Slovaquie : Observations de montagne (Donnersberg) janvier.

REGION D.

Inde Britannique : Observations de ballons-sondes (et téphigrammes) et de ballons-pilotes à l'Agra, août et octobre.

"Indian Daily Weather Report." Août et octobre.

Ceylan : Observations de ballons-pilotes et de nuages, janvier-décembre.

"Report of the Colombo Observatory, 1925."

Chine : (*Hong Kong*) Observations de ballons-pilotes, janvier-novembre.

REGION F.

Australie : Observations de ballons-pilotes et de nuages Adelaide (décembre), Melbourne (janvier-décembre), Sydney (février-mai, août-octobre), Willis Island (décembre).

1926.

REGION A.

Canada : Liste des observations de ballons-sondes pendant le mois international de mai.

Etats Unis : Observations de ballons-sondes (1 station) cerfs-volants (6 stations) et ballons-pilotes (16 stations) pendant le mois international de mai.

REGION C.

Allemagne : (*Lindenberg*) "Aerologische Berichte" Nos. 1-28. "Kurzer Monatsbericht" : Observations de cerfs-volants, janvier-juin, août, septembre, novembre, décembre.

Liste des observations de ballons-sondes, cerfs-volants, avions et ballons-pilotes pendant le mois international de mai.

(*München*) Observations de ballons-sondes (et téphigrammes), janvier, mai, juin, septembre, "Münchener Registrierballonfahrten im Jahre 1926." Observations de ballons-pilotes, janvier, mai, septembre.

Autriche : (*Wien*) Données sur la date des ascensions de ballons-sondes, janvier, mai, novembre.

REGION C.—continued.

Bulgarie : Observations de ballons pilotes et de nuages, janvier, mai, septembre.

Egypte : Observations de ballons-pilotes, janvier.

Espagne : (*Catalunya*) Observations de ballons-pilotes, janvier, mai, septembre.

(*Madrid*) Observations de ballons-sondes (téphigrammes) pendant le mois international de mai ; et septembre. (*San Fernando*) "Anales del Instituto y Observatorio de Marina."

(*Tortosa*) Observations de ballons-pilotes et de nuages, janvier-mai.

France : (*Trappes*) Observations de ballons-sondes (téphigrammes), janvier, février, mai, juin, juillet, septembre-décembre.

Grande-Bretagne : Observations de ballons-sondes (et téphigrammes) pendant le mois international de mai.

Hollande : Observations par avion à Soesterberg et de Kooij, janvier, mai, septembre.

Observations d'un ballon libre, et d'un ballon-sonde et d'un ballon-pilote pendant le mois international de mai.

Hongrie : (*Budapest*) Observations par avion à Szeged pendant le mois international de mai.

Italie : Observations à cinq ou sept stations, janvier, mai, septembre. (*Pavia*) Observations de ballons-sondes (et téphigrammes) pendant le mois international de mai.

Observations de ballons-pilotes, juillet-décembre. Liste des observations de ballons-sondes, janvier-décembre.

Russie (U.S.S.R.) : (*Sloutzk et Leningrad*) "Meteorological Review," janvier-décembre. Bulletin quotidien, janvier-décembre.

Observations de ballons-sondes (et téphigrammes) et de ballons-pilotes, janvier.

Observations de ballons-sondes, avions, cerfs-volants, ballons-pilotes et nuages pendant le mois international de mai.

Suède : Liste des dates des observations à Malmslätt, novembre et décembre.

Suisse : Observations des stations de montagne. Auszug aus den Annalen der Schweizerischen meteorologischen Zentral-Anstalt, mai.

"Das Wetter von Mai."

"Wetterbericht der Schweiz : Met : Zentral-Anstalt in Zürich," mai.

Observations horaires de pression, température et vent à Sântis et Zürich.

REGION D.

Inde britannique : Observations de ballons-sondes à l'Agra, janvier, mai, septembre.

Observations de ballons-pilotes et de nuages à 10-12 stations, janvier, mai, septembre. "Indian Daily Weather Report," janvier, mai, septembre.

Ceylan : Observations de ballons pilotes et de nuages, janvier, mai, septembre.

Chine : (*Hong Kong*) Observations par avion, avril-juillet, septembre-novembre.

Observations de ballons-pilotes, janvier-mai, juillet-décembre.

(*China Sea*) Observations de "shell-bursts," février.

REGION F.

Australie : Observations de ballons-pilotes et de nuages, Adelaide Melbourne, Sydney, Willis Island.

Samoa : (*Apia*) Observations de ballons-pilotes, mai.

1927.

REGION C.

Allemagne : (*Lindenberg*) "Aerologische Berichte" Nos. 1-22 und Sondernummer.

"Kurzer Monatsbericht," Observations de cerfs-volants, janvier, mai.

"Erfahrungsberichte des Deutschen Flugwetterdienstes."

(*München*) Données sur la date des ascensions de ballons-sondes.

Autriche : (*Wien*) Données sur la date des ascensions de ballons-sondes, février, juin.

Bulgarie : (*Sofia*) Observations de ballons-pilotes et de nuages à Bojourichté, février.

Observations de temps et de nuages à Bojourichté, juin.

Espagne : (*Madrid*) Observations de ballons-sondes (téphigrammes) et de ballons-pilotes, février.

(*Tortosa*) Observations de ballons-pilotes, février, juin.

Estonia : (*Tartu*) Observations de ballons-pilotes, juin.

Italie : Observations de ballons-pilotes à sept stations, février.

Russie (U.S.S.R.) : (*Sloutzk et Leningrad*) "Meteorological Review," janvier, février. Bulletin quotidien, janvier-juin.

Suède : Liste des sondages de température à Malmslätt, février et mars; et note sur un sondage par ballon-sonde à Abisko en février.

Tchéco-Slovaquie : Observations de montagne (Donnersberg), mai.

REGION D.

Chine : (*Hong Kong*) Observations par avion, février.

REGION F.

Australie : Observations de ballons-pilotes à Melbourne, Adelaide, Sydney, février.

London,

14th July, 1927.

APPENDIX III.

La Technique des Sondages par Avion.

Comme suite à sa circulaire du 7 juillet, 1925, rédigée aux fins de la Résolution XVII émise à la réunion de Londres en ces termes—

"Les services météorologiques qui se sont occupés de sondages par avion sont priés de vouloir bien adresser au Président de la Commission Internationale de la Haute Atmosphère une description aussi complète et détaillée que possible des instruments (structure et suspension à l'avion) et des méthodes employées."

le Bureau a reçu les réponses suivantes :

INSTITUT ROYAL MÉTÉOROLOGIQUE DE BELGIQUE.

En réponse à votre circulaire du 30 juin dernier, j'ai l'honneur de vous faire parvenir ci-contre, un n° de "Ciel et Terre" (1925 XLI^e année pp. 113-127, 161-167) où a paru la première partie de la description de mon météorographe pour sondage par avion.

Je crois utile de vous signaler que cet instrument s'est révélé parfait pour sa robustesse, la pureté et l'exactitude des graphiques, après un an et demi d'expériences.

L'appareil n'est pas actuellement dans le commerce, mais je pense que prochainement une maison belge en entreprendra la construction.

JAUMOTTE.

Ucele,

le 13 juillet, 1925.

M. KIR. ORSZAGOS METEOROLOGIAI ES FOLDMAGNESSEGI INTEZET.

En réponse à votre circulaire No : 607 158/25/M.O.11 du 7 juillet, 1925, j'ai l'honneur de vous communiquer la suivante :

Pour les sondages en avion on se sert en Hongrie des météorographes destinés spécialement pour avions et fabriqués selon les plans du Professeur Kleinschmidt par la maison Bosch et Bosch, Hechingen. L'instrument mesure la pression atmosphérique au moyen de boîtes de baromètre aneroïde, la température au moyen d'un thermomètre bimétallique et l'humidité au moyen d'un faisceau de cheveux. Comme cet instrument est généralement connu, la description de la construction est superflue.

La suspension se fait diagonalement entre les deux supports d'aile extérieurs à gauche du biplan à l'aide de 4 balances à ressort (dynamomètres) qui au moyen de cables d'allongement tiennent à huit points la boîte plate contenant l'instrument. Le poids de l'instrument s'élève à 2 kilogrammes. Pour amortir les secousses, une traction de 1.5 kilogrammes par dynamomètre se montra la plus efficace, de manière que l'instrument donne des courbes douces et bien utilisables.

Budapest,

le 10 août, 1925.

S. RÓNA,

Directeur.

METEOROLOGISKE OBSERVATORIUM, BERGEN.

I. Suspension.—(a) *The position*.—The general principles for getting accurate measurements of pressure (and also of temperature and relative humidity) are generally known and have been described, e.g., by Wigand and Wienecke (*Beiträge zur Physik der freien Atmosphäre*, Band IX, p. 137 et seq.) and Ahlborn (*Zeitschrift für Flugtechnik und Motorluftschiffahrt*, 1925, p. 2). On biplanes the instrument is hung between the wings about 2/3 of the distance between them and nearer the upper wing. On monoplanes a double fork of light steel tube fixed with four screws, for nuts and steel wire-stays on the frontbeam gives the necessary points for fixing the springs (*see below*). The exact position is selected by horizontal flight at a very low level where the pressure is known in still weather. (Owing to the risks this method has till now only been used here on sea-planes.) If the pressure, registered by an instrument free from errors and just tested, differs by more than 0.5 mm. Hg. from that at the level of the flight, a new position is chosen and the test repeated.

(b) *The fastening*.—The shell (*see below*) containing the instrument is fastened by light steel springs and thin wire. On biplanes the wire is drawn to the ends of struts or points of the nacelle or the wings, on monoplanes to the ends of the above-mentioned forks. The eight points are chosen so that the forced vibrations there when flying are a minimum and the possible movements of the shell only slight elastical vibrations. The springs are made of steel piano wire with a thickness of 1.5 mm. and have a diameter of 15 mm. and a length of 100 mm. The springs are boiled in linseed oil before being used, in order to protect them from rusting. In order to be able to relax the springs when they are not used, they are attached by hooks with small springs in them to strong rings in the shell.

The tension of the springs when attached is chosen so that the system consisting of shell and springs has a free period of vibration of 0.2—0.3 second, which gives practically no vibration during flight, if the motor is making 800–1,400 revolutions a minute.

The wire for attaching the springs to the aeroplane is generally 1.5–2.0 mm. soft iron wire, galvanized or covered with tin in order to prevent rusting.

(c) *The shell.*—The instrument is sheltered during flight by a shell of aluminium—or magaliumplate, approximately streamline-shaped and with a window of mica through which the trace of the pens during the last 10 to 15 minutes can be seen. The plate should be at least 2 mm. thick in order not to be deformed by the springs when stretched. The shell is highly polished in order to reflect radiation effectively. The instrument glides along rails into the shell when inserted or taken out and is secured by means of a hook with lock to the shell, so that it cannot shake inside it during the flight.

II. The instrument.—(a) *General principles.*—The conditions prevailing in aeroplane ascents make necessary certain alterations of the aerological instruments used for kites and registering balloons.

The shocks at start and landing, or during flight in highly turbulent air or at abrupt manoeuvres (which although not permissible in aeroplane-soundings sometimes are unavoidable), the rapid movement horizontally and vertically and the high pressure caused by the high airspeed call for quite a new type of instrument. In order to eliminate the effect of shocks, which are not wholly absorbed by the elastic suspension, the instrument must be stoutly built.

The rapid variations horizontally and vertically must be met by a thermometer and hygrometer of a very low sluggishness.

Possible deformation by wind-pressure must be avoided by using very small surfaces exposed to the wind and if possible profiles of least resistance.

The clockwork must be very solid, not suffer from shocks, have very little back-lash (which is taken up automatically by the driving spring) and a registration-cylinder with large diameter and rapid rotation.

(b) *Details of instrument.*—The base is solid aluminium 3 mm. thick. It is perforated firstly in order to reduce the weight, secondly for the ventilation of the aneroid-boxes.

Thermometer and hygrometer are fixed inside a highly polished wind-channel of diameter 65 mm. The velocity of the air-current, running through this wind-channel, is regulated to 15–20 metres per second by the aid of blinds. (At higher velocities in the channel there is risk of deformation of the thermometer.)

The barometer consists of a set of two or three aneroid-boxes with a compensation-pressure of 450–500 mm. Hg. and $\Delta p = -\Delta T (0.0020 - 0.0004 p)$ (see Kleinschmidt and Hergesell in *Beiträge zur Physik der freien Atmosphäre*, Band I, p. 108).

The thermometer is a bimetallic slightly curved plate of 0.5 mm. thickness, by Bosch and Bosch, Hechingen. It has a sluggishness of the order of magnitude 0.1–0.2 degree Cent. (A cylindrical bimetallic thermometer coaxial with the wind-channel is better.)

The hygrometer is a bundle of 12–15 blond lady's hairs.

The pens are light and broad arms of aluminium plate, 0.2 mm. thick, coupled by levers to the respective instruments in the usual way. They play over a cylinder of 80 mm. diameter and 170 mm. height, which rotates once in two hours and is worked by a strong clock-work. The pens write on aluminium paper covered with soot, which afterwards is conserved by means of a solution of shellak in alcohol. The clock-work can be wound from without the shell, and the pens can be simultaneously put into action or withdrawn from the outside.

The dimensions of the pen-arms and the levers connecting them with the aneroids, the thermometer and the hygrometer are so chosen, that :—

| | | |
|---------|--------------------------|----------------------|
| 0.2 mm. | generally corresponds to | 1 mm. Hg. of 0° C. |
| 1.2 mm. | " | " 1° Centigrade. |
| 0.3 mm. | " | " 1 % rel. humidity. |

III. The sounding.—(a) *Before the start* the instrument is placed in a specially designed thermometer screen of the Norwegian type (*Met. Zeitschrift*, 1915, p. 110) with double louvres and ventilated by a fan driven by a little electric motor. When the whole instrument has the same temperature as the interior of the hut, which never takes more than 15 minutes, the pens are put into action and temperature and relative humidity in the hut read off after 5 minutes. The pressure is read and reduced to 0° C immediately before the readings in the hut. The instrument is kept in the hut until everything is ready for the ascent and then put into the shell. If motor trouble or other circumstances should happen to delay the taking off more than 2–3 minutes in weather with considerable radiation from the sun or the surroundings (in summer) or to the surroundings (in winter), the instrument is thoroughly ventilated for some minutes by rapid run over smooth ground or water and the temperature and relative humidity of the air determined with an Assmann's aspiration psychrometer before the start.

(b) *The flight* is controlled by the meteorologist in charge of the aerological work, who occupies the observer's seat. His work during the sounding is :—

(1) To choose and point out the path to be described by the aeroplane, with the exception of such cases where the pilot thinks the situation critical enough to take over the navigation himself.

(2) To control the path of the aeroplane by means of chart, compass, altimeter, and, if possible, variometer giving the rate of ascent or descent.

(3) To control the work of the instrument, especially temperature and relative humidity (e.g., by the aid of Assmann's aspiration psychrometer) and possible causes of eventual vibrations of the shell (if caused by atmospheric turbulence or by the steering).

(4) To study—if possible, photograph and sketch—and note: Hydrometeoric systems, their positions in space, structure, transformations and relations to other meteorological elements. Atmospheric turbidity, turbulence and optical and eventually electrical or other phenomena of interest to the meteorological work.

It is absolutely essential for the following reasons, that a trained meteorologist conducts the aerological work in the manner just described :—

(1) One cannot, as a rule, ask for observations from the pilot; he has enough to do with the management of the machine, and generally has neither the interest nor the necessary knowledge to see and note the essential things.

(2) The path to be described by the aeroplane in order to get the really representative data of the free atmosphere is a function of the topography and the distribution of land and water of the surroundings of the flying-place, the time of the day and the weather type, and only a trained meteorologist could form a good judgment of the path to be chosen in order to evade misleading or even wrong values being registered by the apparatus. On the other hand, useful and important data can be collected during flights at constant level over areas with different geographical character, especially about the conditions for release of so called 'local showers,' fog, etc. At such an investigation a meteorologist is, if possible, still more indispensable as leader of the flight.

(3) In order to eliminate or at least to be able to calculate the effect of the sluggishness of thermometer and hygrometer the rate of ascent and descent must be kept within certain limits, and, if possible, constant. Those limits are inversely proportional to the lapse rate respectively, the vertical gradient of the relative humidity, which are again functions of the weather situation. Only a meteorologist could, during the flight, with the traces of the pens distinctly visible, say which upper limit should be chosen for the rate of ascent or descent. A good variometer is here a valuable aid for rapid control.

(4) The value of the sounding is very considerably increased by the observations made by a meteorologist during the flight, especially if he is a trained forecaster, sketcher and photographer, because the phenomena in the free atmosphere over a considerable area or a single point can be directly connected with the conditions prevailing at the surface of the earth.

(c) After the landing the instrument is put into the special screen, described above, and controlled in the same manner as before the ascent.

Before conserving the soot coating of the diagrams with shellak solution the circles (with the respective pen-arms as radii) for every characteristic point of the three curves of pressure, temperature and relative humidity are drawn.

IV. The evaluation.—(a) Every characteristic point of the diagram is tested for reality, i.e., if representing a real atmospheric discontinuity, if an approximately horizontal boundary between air masses with different properties, if the limit in a quasi-wave-motion or if it is simply an effect of a practically horizontal displacement from one air-mass to another with different properties, e.g., from cloud under formation to cloudless room, from air over the sea to air rising over adjacent land, etc., in which case the characteristic point should be excluded. Here the notes of the observing meteorologist during the flight are absolutely indispensable.

(b) The further evaluation of the curves is made in the usual manner described, e.g., by Robitzsch (*Die Beobachtungsmethoden des modernen Meteorologen*, Berlin, Gebrüder Bornträger, 1925), and Stüwe (*Arbeiten des Preussischen Aeronautischen Observatoriums*, XIV, 1921).

V. The calibration of the instrument.—The aeroplane-soundings of the Meteorological Observatory, Bergen, are made by the different detachments of the Royal Air Forces of the Norwegian Army and Navy during periods of about one month. Accordingly, the instruments are calibrated immediately before the beginning of these periods in the following way:—

The whole instrument is taken to pieces and every part tested (e.g., the aneroids for leakage, the thermometer for rust-spots or deformations, the hygrometer for damaged hairs, the clockwork for back-lash, regularity of work, etc.), overhauled, eventually polished or oiled (screws and levers are apt to become rusty or dirty), etc.

The revised instrument without hygrometer is then calibrated for temperature in a bath of alcohol. It is essential, that so large a bath is used, that the whole instrument except the clockwork is immersed during the calibration. The instrument described above calls for a bath of 7–8 litres, thermometer and stirring apparatus included. The double cylindrical vessel, containing the bath in its inner part, is insulated with paper and hay and surrounded by a wooden box. At temperatures above 0° C. the outer part of this vessel is filled with water of the temperature for which the test is made, at 0° C. with crushed ice, and at lower temperatures with a mixture of salt and ice. The alcohol is cooled down from higher to lower temperatures with solid carbon-dioxide (produced in the usual way by opening the valve of an iron flask containing the same stuff in liquid form and allowing it to evaporate violently).

The hygrometer is then calibrated by comparison with a standard hygrograph and dry and wet bulb in a ventilated thermometer-screen.

Finally the barometer is calibrated under the receiver of an air-pump (motorpump from Pfeiffer). Firstly a series of rapid cycles between atmospheric pressure and the lowest limit reckoned to be met with are run, and the number of such "blind cycles" determined, which is necessary for reducing the area of the hysteresis cycle to a minimum. Then the calibration is carried out in steps of 100 mm. Hg, first with increasing, then with decreasing pressure so that the points of the curve of increase fall in the middle between those of the curve of decrease. The velocity of the variation of pressure is if possible chosen like that during the soundings, and the vibrations of the instrument reproduced by the aid of an electric motor running at about 1,500 revolutions per minute and placed on the same table as the receiver near it.

The compensation-pressure—or its constancy, that being also a control of the faultlessness of the aneroid-boxes—is then determined at a new series of calibrations with another temperature inside the receiver (generally 10–20° C. lower).

Before an instrument is taken into routine work, its barometer is given the "massage" necessary for reducing the area of the hysteresis curve to a minimum either under the receiver or at chance ascents, where no observations are made.

The calibrations generally hold good for at least a month, provided that the instrument is not too violently shocked at start and landing.

The variations recorded in the screen can be used as a control of the constancy of the calibration curves.

ERNST G. CALWAGEN,
Director of Observatory.

Bergen, 1925.

UNITED STATES DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.

In accordance with the resolution passed by your Committee wherein request is made of the various meteorological services engaged in making soundings by means of airplanes, I take great pleasure in submitting the following report regarding this work in the United States.

During the present year the Weather Bureau, co-operating with the Bureau of Aeronautics, Navy Department, has undertaken to make regular observations by means of airplanes at Washington, D.C.

The data are made available to the forecaster at the Weather Bureau in time for use in making the regular daily forecasts and include the temperature and relative humidity at those heights between which the change in elements is linear and therefore obtainable by interpolation.

It has thus far been found that the Marvin-type meteorograph such as is used in our regular kite flying is exceedingly well adapted to this work. The wind element of the instrument is removed and a strong piece of screening is placed across the front opening of the screening tube containing the temperature and humidity elements. This serves admirably to protect the delicate elements against the violent air currents.

A detailed description of this instrument may be found in the Weather Bureau publication No. 740, entitled "Instructions for Aerological Observers," (1921), a copy of which is undoubtedly available to the Committee.

With reference to the manner of suspending the instrument from the plane, it may be stated that very excellent results are being obtained by the use of a device adapted by the Bureau of Aeronautics wherein the meteorograph is suspended by means of bungee (rubber) cord and wire to the inside of an iron frame or cage, secured to the top, centre, of the upper wing of the plane. This frame is placed on a suitable wooden base and stayed by means of piano wire with 5-inch turnbuckles extending from its corners to the hoisting fittings of the plane and is readily removable.

It has been found most practicable in making these observations

regularly to leave the meteorograph's cover fastened to the inside of the iron frame, simply removing the instrument from its cover between observations.

The effects of vibration of the plane are practically entirely eliminated so far as these records are concerned and very satisfactory traces are ordinarily procured, there being frequent occasions when the trace is less than 1 mm. in width throughout.

There are inclosed herewith some photographs of the mounting device and of the Marvin-type meteorograph which is now being used.

Washington.

August 18, 1925.

C. F. MARVIN,
Chief of Bureau.

DEUTSCHE SEEWARTE.

Bei den aerologischen Aufstiegen mit Flugzeug wird bei der Deutschen Seewarte seit dem Jahre 1920 nur der Meteorograph von Marvin (in der Herstellung der Firma Bernh. Bunge Berlin-Lichterfelde) verwendet, und zwar von Anfang an ohne irgend eine Einschränkung der Ventilation durch den Fahrtwind. Für die Aufhängung im Flugzeug mussten je nach dem benutzten Typ verschiedene Anordnungen ausgebildet werden, indem teils der Apparat durch Federzüge zwischen den Tragflächen elastisch verspannt oder an Federn freischwebend aufgehängt wurde, derart, dass das Ventilationsrohr des Apparates im Fluge möglichst horizontal und in der Flugrichtung steht.

Es ist bei der Deutschen Seewarte im Anschluss an die Berichte in "Annalen der Hydrographie usw." 1922 Bd. L, Heft 4 und 1923 Bd. LI, Heft 5, die zusammenfassende Bearbeitung der Aufstiege und ihrer Ergebnisse von 1923-1925 im Gange, wobei den instrumentellen Erfahrungen besondere Aufmerksamkeit gewidmet werden wird. Die Deutsche Seewarte wird sich erlauben, von dieser Arbeit s. Zt. nach Erscheinen einige Sonderabdrücke für den Gebrauch der "Commission de la Haute Atmosphère" zu übersenden.

Hamburg 9, den 20. August, 1925.

CAPELLE.

METEOROLOGICAL OFFICE, LONDON.

For the purpose of regular observation, the instruments employed are purely eye-reading instruments. Trials have been made from time to time, and are still being made, with self-recording instruments of various forms, but it has not yet been thought desirable to adopt any such instrument for the purpose of obtaining regular data.

The practice is to take simultaneous readings of wet and dry bulb temperatures at an indicated height of 1,000 feet, then at pressures of 950 mb., 900 mb. . . . to as great a height as can be reached. Readings are taken during both ascent and descent and in order to overcome the effects of lag, the machine is flown horizontally for one minute before taking the readings at each pressure. Ground readings are taken before and after the ascent, a mercurial barometer being used for the purpose of setting the aneroid barometer used on the machine. Additional observations are taken of the height and amount of temperature-inversions, and data relating to cloud and visibility are also included. "Grebe" machines are now employed for this work at the Duxford aerodrome where a special "Meteor. Flight" detailed for the work is posted. With these machines a height of 20,000 ft. is frequently exceeded. Observations are also obtained from South Farnborough, and, irregularly from one or two other stations.

Instruments.—For pressure, a special form of aneroid, graduated from 1,050 mb. to 400 mb. is used. It is of high-class construction and precautions are taken, by the provision of a controlling hair spring of suitable stiffness, to prevent excessive vibration of the needle. Aneroids are recalibrated every three months at headquarters, in a suitable pressure chamber.

For the wet-and-dry-bulb observations, the standard instrument is the "aeroplane psychrometer." This consists of two mercurial thermometers graduated from +85° F. to -40° F., mounted side by side on a wooden frame shaped suitably for mounting on a wing strut about 4 feet from the cockpit. Lenses of about 4 inches focal length are mounted at the correct distance in front of the thermometers on a sliding frame which may be raised or lowered by the observer through the intermediary of a cord or, preferably, a bowden wire. The observer, normally the pilot, then obtains an enlarged view of the thermometer tubes and scales and can, in favourable circumstances, take readings to 0.1° F. The leading thermometer is used as a dry bulb and the following as a wet bulb, a suitable cistern to contain water being provided at the base of the frame.

Use is also made of a distant reading mercury-in-steel thermometer indicating on a dial in the cockpit, and of a large spirit thermometer ("strut" thermometer) which can be read directly from a distance of several feet to about 0.5° F. Difficulty in adapting the former type of thermometer for use as a wet bulb has prevented its more extensive adoption. The "strut" thermometer suffers from the defect that it involves the use of a large bulb and the lag thereby introduced is fairly considerable. Thermometers of this type can be used also as wet bulbs and it has been found convenient to utilize them for both wet-and-dry-readings on machines such as the "Grebe" where the nearest wing strut is at too great a distance to permit of the effective use of the aeroplane psychrometer.

SVENSKA METEOROLOGISK-HYDROGRAFISKA ANSTALT.

I. Construction de l'instrument.—Les météorographes employés sont de la Maison Bosch et Bosch, type Kleinschmidt. Leurs dimensions (sans cage protectrice) sont : longueur 270 mm., hauteur, 180 mm. ; leurs poids est de 892 g. La cage pèse 610 g.

La pression est mesurée à l'aide d'une couple de boîtes anéroïdes—diamètre 72 mm. et épaisseur 8 mm.

La température est déterminée au moyen d'une bilame laiton-acier, épaisseur 1.2 mm., longueur 102 mm., largeur moyenne 27 mm., recourbe avec un rayon de courbure de 270 mm.

L'humidité relative est mesurée à l'aide d'un hygromètre à cheveux, longueur des brins 155 mm.

Le cylindre de l'enregistreur fait un tour en 4 heures. On a réservé pour l'enregistrement des différents éléments les espaces approximatifs que voici : 90 mm. pour la pression entre 800 et 260 mm. Hg., 80 mm. pour la température entre -30° et +35° C., 30 mm. pour l'humidité relative entre 0 et 100 per cent. Les instruments sont garnies d'une enveloppe à aluminium, qui est coupée en deux, pour faciliter son enlèvement.

II. Étalonnage de l'instrument.—On immerse le thermographe d'abord dans un bain froid, alcool et CO₂ solide, environ entre +15° et -40° C. et puis dans un bain d'eau chauffé entre +15° et +35°. Pour la vérification du barographe on met l'instrument sous une cloche en verre où l'on fait à l'aide d'une pompe à air liée à un manomètre à mercure. En fin l'hygrographe est comparé avec un psychromètre à aspiration à la température et à la pression ordinaire.

III. Suspension des météorographes.—Les météorographes sont suspendus à l'aide de 4 amortisseurs en caoutchouc longueur environ 45 cm., fixés aux bouts des deux montants extrêmes d'un biplan, plus un amortis-

seur horizontal réunissant les points milieu des dits montants, tous les cinq dans un même plan.

L'instrument oscille à peu près 3 fois en une seconde.

IX. *Lieu d'observation.*—Les ascensions aérologiques se font à 9 h. du matin environ au champ d'aviation de Malmslätt (Lat. : 28° 24' N., Long. : 15° 31' E. de Gr. 115 m, au-dessus de la mer). Les observations comparatives au niveau du sol à l'aide d'un baromètre à mercure et d'un psychromètre à aspiration, comme aussi le dépouillement préliminaire des courbes enregistrées après l'atterrissage, sont confiés à des étudiants accomplissant leur service militaire au champ d'aviation, après un examen à l'Institut Central, et qui par conséquent ont reçu une instruction spéciale en météorologie.

V. *Code employé.*—Le résultat du sondage est communiqué par télégramme à l'Institut Central de météorologie et répété dans le radiogramme international "Météo Suède." On donne les points caractéristiques de la courbe de température et les valeurs correspondantes de l'humidité, de la pression et de l'altitude. C'est la monté qui nous fournit les renseignements les plus exactes, car la descente est généralement trop rapide. Les sondages sont donnés dans le code suivant :

ZZU₁U₂ ÖÖTTT PPBBB HHTTT PPBBB ... etc.

niveau de la station.

où les lettres symboliques indiquent :

- ZZ L'heure ronde (en temps moyen de Greenwich) du sondage.
 U₁ 5 Sondage par cerf-volant.
 6 Sondage par ballon captif.
 7 Sondage par avion.
 8 Sondage par ballon-sonde.
 U₂ 3 Toutes les données se rapportent à la monté.
 4 Toutes les données se rapportent à la descente.
 5 Toutes les données sont des moyennes de la monté et de la descente.
 6 On ne peut pas dire ni 3, ni 4, ni 5.
 8 Les données sont incertaines.
 HH Hauteur au-dessus du niveau de la mer en hectomètres correspondant au point caractéristique en question.
 TTT Température en dixièmes de degrés centigrades.
 PP Humidité relative ; 100 pour cent. PP=99.
 BBB Pression en millimètres entiers de mercure.

VI. *Dépouillement des courbes.*—Les courbes sont tracées sur du papier d'aluminium enfumé. Avant d'enlever la feuille au cylindre enregistreur et avant le fixage du diagramme au vernis à la gomme-laque, on fait tracer aux styles des cercles passant par chaque point saillant des courbes de température, de pression ou d'humidité. Ces repères ont pour but d'assurer l'isochronisme de lecture des trois éléments. Puis on évalue au moyen des courbes d'étalonnage les ordonnés pour ces points et enfin on se sert du papier adiabatique (Maison Schleicher et Schüll) pour la détermination des hauteurs.

VII. *Les résultats* sont portés sur un formulaire spéciale.

Stockholm,

Le 20 novembre, 1926.

FLUGSTELLE TEMPELHOF DES OBSERVATORIUMS LINDENBERG.

Als Flugzeugmeteorograph eignet sich nach unseren Erfahrungen am besten der auch als Drachenmeteorograph am Aeronautischen Observatorium benutzte Apparat von Bosch und Bosch. Die Anforderungen an die Apparatur sind im Flugzeug und Drachen nahezu die gleichen. Nur die äussere Form des Instruments musste etwas geändert werden.

Zur Erzielung grösserer Festigkeit wurde der ganze Rahmen des Instruments kräftiger gehalten und der äusseren Verkleidung eine möglichst windschnittige Form gegeben. Die innere messtechnische Ausgestaltung ist für die Aufstiege vollkommen ausreichend und wird bisher von keinem bekannten Instrument übertroffen. Die Anbringung der Messorgane ist denkbar günstig und übersichtlich. Die Registrierung krummliniger Koordinaten ist nicht als Nachteil anzusehen.

An Neuerungen sind lediglich der in letzter Zeit in zwei Apparaturen nach meinen Angaben erfolgte Ersatz der Registrieruhren durch Pellerantrieb der Registriertrommel, und weiter eine besondere Einrichtung, um von Hand aus Zeitmarken vom Beobachtersitz aus auf den Apparat zu geben, zu nennen. Beide haben sich bisher gut bewährt.

Die Aufhängung der Apparate erfolgte bei unseren Eindeckern etwa 3/4 m unter dem Tragdeck an Gummischnüren in einem Eisenrahmen. Die am Flügel auftretende dynamische Druckverfälschung ist dort nur sehr gering, liegt jedenfalls unterhalb der Messgenauigkeit. Bei Doppeldeckern ist zur Aufhängung der von Druckverfälschungen freie Raum zwischen den Tragflächen etwa 1/3 unter der oberen Fläche benutzt worden. Nähere Einzelheiten siehe in den Arbeiten des Aeronautischen Observatoriums Lindenberg Bd. XIV und XV unter den Ergebnissen der Flugstelle.

Lindenberg.

Februar, 1928.

On nous communique du Chili, du Danemark, des Indes, de Ceylan, de Shanghai, du Brésil, de l'Islande, de l'Autriche, et de la Suisse qu'aucun sondage par avion n'a été exécuté jusqu'ici.

METEOROLOGICAL OFFICE,
 AIR MINISTRY, LONDON, W.C.2.
 June, 1927.

APPENDIX IV.

Notes on the specimen volume of Comptes-rendus, 1923.

(a) MEMORANDUM CONCERNING THE VARIABLES OF DYNAMICAL METEOROLOGY AND THEIR UNITS.

By Professor V. Bjerknes.

"The central problem of dynamical meteorology is that of the atmospheric motions. The other factors determining the weather are incidental phenomena accompanying the great atmospheric mass-displacements, which depend upon the relation of the fields of pressure and of mass to that of gravity.

The Gravity Field.

The gravity-field is described by the gravity-potential. The horizontal course of the equipotential or level surfaces is determined by levelling. Their potential (geopotential) is found, either indirectly by combined measurement of vertical distances and acceleration of gravity, or directly by the so-called "barometric measurement of heights," which, just as levelling, is a direct measurement of potentials, and only indirectly of heights.

The obvious method of studying the relation of the fields of pressure and mass to gravity consists in choosing the geopotential as one of the independent variables, and registering the dependent variables in relation to it. In case of aerological ascents with registering instruments, this is simply attained by letting the "barometric measurement of height" remain what it is, viz., a measurement of potential. If the geometric height is one of the measured quantities (ex. pilot-balloons) it may by a table easily be changed into potentials. In order to remind one of the

simple numerical relation between geopotential and height, it has been proposed to call the unit of potential used practically "dynamic metre." The number which expresses the geopotential of a locality in dynamic metres will then only differ about 2% from the number expressing its height above sea-level in metres.

Registering the observed quantities according to *heights* instead of according to geopotentials, one simply loses what one is looking for, namely, the relation of the fields of pressure and of mass to that of gravity. The work for getting back to this relation will then go through interpolations of all registered variables back from the slanting surfaces of equal height above sea-level to the horizontal surfaces of equal potential, and from the intervals given by integer numbers of geometric metres to the intervals given by integer numbers of dynamic metres. Or, the greatest danger of all is that one is tempted to save the enormous trouble of these recalculations, seeking comfort in the thought that the errors are small, but without being able to determine their consequences. The atmospheric motions, namely, always depend upon small differences between the observed quantities, and we do not know beforehand how small the deciding difference may be in critical cases.

The only rational plan will, therefore, be from the very beginning consistently to use the natural variables of the problem. It gives least trouble and saves us from all dangerous complications or temptations.

This question of the use of the geopotential as one of the independent variables has nothing to do with the question of the choice of rational or irrational units. No irrational unit has hitherto been proposed for geopotential. The only units at our disposal are the absolute c.g.s. unit, and its decimal multiples. Of these 10^5 c.g.s. units of geopotential has been found to be the most convenient in practical use, and has been called the dynamic metre.

Field of Pressure and Mass.

The study of the atmospheric motion must start from that of *atmospheric equilibrium*. The great chance, which makes it possible to advance at all, is that the atmospheric motions are due to very small departures from the equilibrium conditions.

During equilibrium, when we have no field of motion, the fields of pressure and mass have a very simple relation to the field of gravity. The field of mass is described by the *equisubstantial surfaces*, which, according to the circumstances, may be numbered according to units of density (i.e. mass per unit volume) or units of sp. volume (i.e. volume per unit mass). The equilibrium conditions are that—

both *equisubstantial* and *isobaric* surfaces coincide with the *equipotential* ones: and in such a way that the number expressing sp. volume gives the number of unit equipotential strata contained in a unit isobaric stratum, or, equivalently, that the number expressing density gives the number of unit isobaric strata contained in a unit equipotential stratum.

But this simple harmony is lost, not only when an unsuitable variable is used, as height instead of geopotential, but also if the variables are expressed in an incoherent system of units.

Now we always express geopotential, always density, and always sp. volume in units belonging to the c.g.s. system. The only quantity for which we shall have a chance of using units not belonging to this system, is pressure. When it is done, already the simplest law of dynamical meteorology, the law of equilibrium, takes distorted form. Sp. volume is no longer expressed by the same number which gives the number of equipotential unit strata in an isobaric unit stratum. And density is no longer expressed by the same number which gives the number of isobaric unit strata contained in an equipotential unit stratum. Then passing from statics to dynamics, we meet with increasing confusion. A new quantity, velocity, which is to be expressed in rational units, shall be calculated from a complex of quantities of which all except one, pressure,

are expressed in the c.g.s. units. The fundamental law connecting mass, acceleration and force then comes into application in two different forms, namely, in the form of the classical *equality* for the force of gravity and for the deviating force of the earth's rotation, but in the form of a *proportionality* for the force originating from pressure.

Only those who have tried it themselves know what confusion and extra trouble this brings. The c.g.s. system of units has been introduced just in order to do away with all the difficulties originating from units chosen at random, and to get rid of the proportionality factors which must be introduced to compensate for the incoherence of the unit-system. The c.g.s. system requires no defence. Wherever it has been introduced, it has stood the test. It has brought simplicity, clearness and labour-saving everywhere.

Dynamical meteorology is one of the most difficult branches of physics. Less than any other branch can it do without the advantages of the absolute system of units. And even climatology will want this system of units as soon as it tries to penetrate beyond the statistically stated results to the underlying laws of nature."

(b) NOTE ON GEOPOTENTIAL.

By Col. E. Gold.

"I hope if the Commission accepts geopotential as the co-ordinate to be used in the publication of upper air results, it will recommend also that the geopotential should be given (in addition to the geometric height) for all stations for which values of pressure are published. If that were done it would result in appreciable economy for everybody concerned; it makes the tables for the reduction of *pressure* to sea-level independent of latitude if geopotential is the argument instead of geometric height. It seems to me so much more scientific to calculate once for all the geopotential of the station than to apply to every value of pressure a correction on account of the variation of gravity with latitude and altitude.

I have used the word *pressure* advisedly because it would be necessary to correct the readings of a mercurial barometer on account of the value of gravity at the station before the pressure at station level could be obtained.

I have been looking at the volumes of the results which you have produced; it is a great task, and I hope the young people will show their gratitude by using the results collected together. I appreciate very much the value of reproductions of the curves showing the details of the individual ascents. I should have found it much easier to arrive at a decision as to where the troposphere ended and the stratosphere began in the work I did in 1909-12 if I had had curves instead of tables: although I regard tables of numerical values as an essential part of the presentation of the results."

(c) ZERO OF TEMPERATURE.

Proposal by Dr. L. F. Richardson.

"That the International Bureau of Weights and Measures (at Sèvres) be asked to state the thermodynamic temperature of the ice-point to the nearest tenth of a degree centigrade; and that their statement be used in computing all temperature in those publications of the Commission in which tenths of a degree are printed."

(d) NOTE ON UNITS IN THE INTERNATIONAL PUBLICATION.

By Mr. J. Patterson.

"The system of units is undoubtedly one of the most important questions before the Commission at present, and I am strongly of the opinion that now when the work is being reorganized and is still in the early stages of development that the proper system of units should be used. It seems to me that, on account of the Upper Air Investigation as carried on by the International Commission being confined to meteorologists and scientists, it gives a most excellent opportunity and one that should not be missed of

having all the data published in the system of units used in the specimen volume. It does not take any more time, in fact not as much, to work up the results by the methods used in the volume."

APPENDIX V.

Rapport sur les travaux d'exploration de la haute atmosphère effectués en Suède depuis 1924.

By Dr. A. Wallén.

SONDAGES PAR AVION.

Dès 1923 l'Institut de météorologie et d'hydrographie s'est assuré la collaboration des autorités militaires pour l'exploration des hautes couches de l'atmosphère, surtout celles situées en-dessous de 5 km. C'est au camp d'aviation de Malmslätt qu'ont été faites la plupart des sondages par avion; quelquefois leur point de départ a été Skillingaryd, Rinkaby ou Rättvik. On a employé exclusivement des météorographes Kleinschmidt, suspendus aux deux montants extrêmes des biplans, à l'aide d'amortisseurs en acier ou en caoutchouc. Le nombre des sondages, de 170 en 1924, s'élève actuellement à 190 environ par an. Une nouvelle station permanente sera établie sous peu à Östersund. Une étude très détaillée des sondages de 1924 et 1925 a été publiée par M. F. Lindholm, en charge de ces travaux, dans les "Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt" Band 3 No. 10, Stockholm 1927, sous le titre: "Sur la structure thermique de l'atmosphère au-dessus de la Suède méridionale." L'étalonnage des instruments ainsi que la lecture des courbes enregistrées se font toujours à l'Institut, à l'exception d'une lecture préliminaire destinée aux radiométéogrammes internationaux, qui se fait au camp d'aviation même.

CERFS-VOLANTS.

Abstraction faite d'une série d'essais de la Marine Royale à Carlskrona on n'a plus tenté d'enlever des météorographes à l'aide de cerfs-volants. Le pays étant sillonné par des lignes de transport d'énergie électrique, le lancement des cerfs-volants est devenu d'ailleurs d'année en année plus précaire.

BALLONS-PILOTES.

L'établissement de stations de lancement de ballons-pilotes, grâce au développement de l'aviation marchande, procède d'une manière satisfaisante. En plus de la station d'Abisko qui fonctionnait de 1913 à 1915 et qui fut rétablie en 1921, celle de Stockholm établie en 1919, d'Östersund établie en 1921, et de Malmslätt qui fonctionne depuis octobre 1923, on a installé le 1^{er} juin 1926 des postes semblables à Malmö et à Göteborg. A ces postes, qui lancent régulièrement chacun environ 265 ballons par an, s'ajoutent des postes temporaires de la Marine et de l'Armée, p. ex. à Håstholmen et Oscar Fredriksborg dans l'archipel de Stockholm, au Fort du Kungsholm près de Carlskrona, à Skillingaryd, à Boden, à Rinkaby, etc. Les carnets de repérage des ballons sont recueillis à l'Institut de météorologie et d'hydrographie, où l'on prépare actuellement la publication des résultats sous une forme très condensée, pouvant satisfaire à la fois les besoins de la science météorologique et des communications aériennes.

BALLONS-SONDES.

Depuis l'établissement, en juillet 1921, de lancers réguliers aux jours internationaux de ballons-sondes, on a lancé en tout 113 ballons, dont 40 ont été retrouvés malgré la contrée presque déserte où est situé le lieu choisi, Abisko. Il est vrai qu'une grande partie des ballons a été retrouvée en Norvège et même en Finlande, après des parcours dépassant parfois 600 km. Pour porter l'attention à l'équipage, on a muni les lattes de bambou protégeant l'instrument de petits pavillons multicolores et en

plus un ballon supplémentaire, moins gonflé que le principal, est attaché à l'équipage. Après la chute, celui-là reste en l'air où il sert en quelque sorte comme signal. On emploie exclusivement des météorographes Dines, et la méthode d'étalonnage et d'interprétation des clichés est rigoureusement celle de M. Dines. 25 des clichés ont été dépouillés et les résultats figurés sur des diagrammes selon température et log pression, avec adjonction de la hauteur des points caractéristiques et des couches de pressions principales. Les résultats diffèrent singulièrement de celles obtenues par le regretté H. Maurice à Kiruna en 1907-1909. On n'a trouvé de température plus basse de -58.5° ; la hauteur de la tropopause n'a varié que de 7.3 km. à 11.6 km.; presque toujours la couche dite isotherme est caractérisée par une inversion marquée, exigée d'ailleurs par la dynamique de l'atmosphère. Le tableau ci-dessous résume les enregistrements des ballons ayant atteint au moins 9 km.:

| Date. | G.M.T. h. m. | Altitude. Tropopause | Température. | Maximum Altitude. | Température corrte. |
|--------------|-----------------|-------------------------|-------------------------|----------------------|-------------------------|
| 1921 juillet | 7 8 47 | 10.6 km. | -51.5°C | 17.9 km. | -37.0°C |
| | 18 18 00 | 11.3 | -53.0 | 14.3 | -45.0 |
| | 8 8 43 | 9.5 | -56.0 | 9.9 | -55.0 |
| déc. | | | | | |
| 1922 janv. | 5 8 38 | 9.9 | -58.5 | 11.2 | -55.0 |
| | 11 7 31 | 11.6 | -54.0 | 15.4 | -48.0 |
| sept. | 12 7 20 | 10.5 | -48.5 | 11.4 | -41.5 |
| | 15 7 21 | 10.1 | -54.5 | 16.9 | -42.0 |
| 1923 févr. | 12 7 35 | pas atteinte | | 9.9 | -54.5 |
| | 16 7 15 | 8.7 | -54.0 | 19.3 | -46.0 |
| | 17 7 24 | 8.8 | -57.5 | 9.1 | -57.0 |
| juin | 12 8 32 | 9.6 | -53.5 | 15.8 | -41.2 |
| | 14 18 15 | 9.3 | -53.5 | 13.5 | -39.5 |
| oct. | 17 7 03 | 9.1 | -56.0 | 13.7 | -44.5 |
| | 19 7 25 | 8.9 | -55.0 | 11.0 | -47.0 |
| 1924 mars | 21 7 10 | 7.3 | -56.2 | 9.1 | -50.0 |
| | 22 7 01 | 7.5 | -56.2 | 13.2 | -48.0 |
| sept. | 4 10 59 | pas atteinte | | 10.3 | -46.5 |
| | 18 59 | pas atteinte | | 9.0 | -34.5 |

Les ballons ci-dessous ont été retrouvés jusqu'à présent:

1921 juillet 7 & 18; octobre 6; décembre 8.
 1922 janvier 5; septembre 11, 12, 15 & 16.
 1923 février 12, 16 & 17; juin 12 & 14; octobre 15, 17, 19 & 20.
 1924 mars 21 & 22; juillet 19; septembre 4 (4 ballons); novembre 11.
 1925 janvier 24; avril 14, 15 (2 ballons) & 16; août 17 & 20; décembre 17.
 1926 septembre 14.
 1927 février 15, 16 & 17; juin 15, 16 & 29.

La rédaction pour l'impression, différée par suite d'une manque de personnel, est en cours.

Stockholm,
le 27 août 1927.

APPENDIX VI.

Registrierungen des Zugs im Haltekabel eines Drachengespanns mittels Dynamometeranordnung.

Dr. H. Hergesell.

Am Observatorium Lindenberg wird schon seit einem Vierteljahr der bisher nur gelegentlich abgelesene Zug im Drachendraht auf mechanischem Wege registriert. Das an der neuen Winde befindliche Dynamometer hat

zu diesem Zweck neben dem Zeiger noch eine über einen Winkel arbeitende Schreibfeder erhalten, die auf einer Registriertrommel mit wahlweise 1, 2, oder 4 Stunden Umlaufzeit mit Registriertinte den Verlauf des Zuges aufschreibt. Im wesentlichen wird mit zweistündiger Umlaufzeit gearbeitet. 1 Minute entspricht dann etwa 3 mm. Transport des Registrierpapiers.

Damit nicht alle kleinen Schwingungen des Drachendrahtes ein Verwackeln der Zugregistrierung mit sich bringen, ist eine ziemlich kräftige Öldämpfung in den Zugmesser eingebaut. So wurde es erreicht, dass die Registrierungen sich im wesentlichen auf die Wiedergabe der zeitlichen Änderungen des Zuges beschränken. Hier und da ist natürlich ein Verwackeln nicht zu vermeiden. Siehe hierzu Kurve IV der beigegebenen Registrierungen.

Ein Nachteil des Instruments liegt bisher noch darin, dass die Überleitung der momentanen Zugwerte eindeutig auf eine bestimmte Höhe zunächst nur auf dem recht unbequemen Umwege über die Zeit gemacht werden kann. Zu einer zweckmässigen Einrichtung gehören aber schnelle Vergleichbarkeit von Drahtlänge, Auslassgeschwindigkeit, Zeit und Drachenzug. Eine entsprechende Verbesserung der Apparatur ist in Bau.

In den beigegebenen Kurven I-III sieht man mit einiger Übung, dass das Ausscheiden aller mitregistrierten Einflüsse durch die Bedienung der Winde (Ein- und Auslassen, Änderung der Geschwindigkeit, Ansetzen von Hilfsdrachen) gestattet, recht gut die Lage der turbulenten Zonen und auch der Sperrschichten der Atmosphäre. Mit der vergleichbaren Erfassung mit dem Registrierergebnis des Meteorographen ist aber der Zweck der Apparatur erfüllt. Wegen weiterer Einzelheiten wird auf die Mitteilungen des Aeronaut. Observatoriums Lindenberg verwiesen.

[The curves I-IV referred to in this note are not reproduced.—Editor.]

DISCUSSION.

Dr. Moltchanoff: "The investigations of gustiness are very important, and the Aerological Observatory in Pavlovsk has taken observations from the beginning of the year, using for this purpose a special meteorograph. The investigation of vertical currents is rather difficult, because up to the present there has been no recognized method in use. The results of ascents of pilot-balloons by observations from two points cannot be used because the vertical velocity of the pilot-balloon is dependent on several different factors. The results of pilot-balloon observations could not be utilized for air-sheets of small thickness at great heights. In this case the error of the results must be taken into account and the thickness of the sheet must be sufficiently great. The theodolite for pilot-balloon ascents from two points requires a vernier by which the values of angles can be read easily 10 to 15 minutes after the beginning of the ascent, for then the changes in the angles are very small."

Dr. H. G. Cannegieter: "The Dutch pilots who regularly make daily ascents for aerological observations are charged to take notice of the turbulent layers in the atmosphere. These notes about the height and extension of the turbulent layers are published as 'Bemerkungen' in the publication 'Aerologische Beobachtungen.' They can be published daily in the weather reports as a supplement to the several figure-groups giving the results of the ascent."

Dr. F. Linke: schlägt vor mit Hilfe des Wetterdienstes an den Flugplätzen die täglichen Beobachtungen der Piloten des regelmässigen Luftverkehrs über die Turbulenz der Luft in verschiedenen Höhen zu sammeln und zu publizieren.

Dr. Th. Hesselberg: "Als ich einmal die Frage mit Wenger diskutierte erwähnte er dass man (1) durch Änderung der Form, (2) durch Belastung, oder (3) durch Raumachen der Oberfläche des Ballons das kritische Gebiet der Reynoldsen Zahl verschieben könnte."

APPENDIX VII.

Aerologische Ergebnisse der Meteor-Expedition 1925-27.

Prof. Hergesell teilt folgendes mit:—

Wie bereits bekannt sein dürfte hat die Meteor-Expedition eine grosszügige Erforschung des Südatlantik auf ozeanographischem und meteorologischem Gebiet vorgenommen, die bei einer grossen Zahl von Kreuzfahrten gewonnen wurden. Es sollen hier nur einige Hauptergebnisse der aerologischen Arbeiten berührt werden.

Zur Erforschung der freien Atmosphäre hat die deutsche atlantische "Meteor"-Expedition 1925-27 insgesamt 812 Pilot-visierungen, 217 Drachenaufstiege und 7 Registrierballonaufstiege gemacht. Ausserdem wurden die Höhenwindmessungen durch zahlreiche Beobachtungen des ci Zuges ergänzt.

Die Registrierballonaufstiege konnten wegen der zu geringen Schiffsgeschwindigkeit nicht in der gewünschten Anzahl ausgeführt werden. Ein Aufstieg auf 37° N.Br. traf die Stratosphäre in 10,200 m. Höhe an, ein Aufstieg in 15° S.Br. westlich von St. Helena hatte die Stratosphäre in der Plathöhe von 14,200 m. noch nicht erreicht.

Da jedoch eine grosse Anzahl von Pilotballonen weit über die Troposphäre hinaus verfolgt wurden, so wird sich aus diesen häufig die Stratosphärengrenze ermitteln lassen. Sie prägt sich nämlich fast stets durch eine auffallende Windänderung aus, so dass schon vielfach im Beobachtungsprotokoll der Vermerk "Stratosphärengrenze" gemacht werden konnte.

Die Drachenaufstiege lieferten vor allen Dingen wertvolles Material zur Erforschung der Passate. Innerhalb der beiden Passatgürtel und der eingeschlossenen Äquatorialzone wurden mehr als 150 Aufstiege gemacht. Ueber den Südostpassat hat *Reger* bereits eine kurze Mitteilung in den "Beiträgen zur Physik der freien Atmosphäre" (Bd. XIII S.59) gemacht. Eine entsprechende über den Nordostpassat wird demnächst erscheinen.

Die Passate sind hiernach feuchte Kaltluftkörper mit adiabatischer Temperaturabnahme. Darüber liegt ein trockener Warmluftkörper, in welchem die Temperaturabnahme unteradiabatisch ist. Die Begrenzung der beiden Luftkörper befindet sich in wellenförmiger Bewegung und weist einen mehr oder minder starken Temperatursprung auf. An der afrikanischen Küste sind die Passatschichten sehr flach; sie steigen dann nach Westen zu rasch auf 1,200-1,500 m. an und erreichen mit Annäherung an die südamerikanische Küste zuweilen eine Dicke von 2,000 m.

Zwei Wolkenetagen sind typisch für den Passat: das Fr-cu Niveau in 300-700 m. Höhe und das st-cu-Niveau an der oberen Grenze. Vielfach sind beide gleichzeitig vorhanden.

Im Äquatorialgebiet stossen die beiden Passate aufeinander und bringen zum Teil Einbruchregen, zum Teil Aufgleitregen.

In zwei Fällen konnte im NE Passat deutlich die Verstärkung des Passatwindes beim Vorüberziehen von grossen nordatlantischen Depressionen beobachtet werden.

Der Redner schliesst mit dem Ausdruck der Freude darüber dass die grosse Arbeit bei einem glücklichen Ende geführt werden konnte. Auf diese Weise ist ein ausserordentlich wertvolles Material zusammengekommen, dass jetzt bearbeitet und veröffentlicht werden soll.

APPENDIX VIII.

Summary of Papers submitted by P. A. Moltchanoff, Slutzk.

1. APPARAT ZUR ÜBERTRAGUNG DER ANGABEN VON MESSINSTRUMENTEN IN ANWENDUNG AUF DIE AEROLOGIE.

Das Prinzip des Apparates besteht darin, das konzentrisch mit den Zeigern der Empfänger, welche auf die Quadranten eines Kreises verteilt sind, ein Zeiger sich bewegt, der durch ein Uhrwerk bewegt wird. Der

Zeiger schliesst der Reihe nach einen ständigen elektrischen Kontakt und die Kontakte der einzelnen Zeiger der Empfänger. Die Kontakte werden mittelst eines Drahtes (Fesselaufstieg) oder durch T. S. F. (Registrierballone) auf einen Chronographen übertragen. Das Verhältniss des Zeitintervalles zwischen dem ständigen Kontakt (Doppelkontakt) und einem der drei nacheinanderfolgenden, den Zeigern der betreffenden Empfänger entsprechenden Kontakte zum Zeitintervall zwischen demselben Kontakt und dem nächsten Doppelkontakt gibt die Lage des entsprechenden Zeigers auf dem Kreise. Für eine gute Funktion des Apparates ist nur eine regelmässige Drehung des Uhrzeigers und der Chronograph-entrommel erforderlich.

2. ENTWICKELUNG DER AEROLOGIE IN ZUSAMMENHANG MIT DEN MODERNEN FORTSCHRITTEN DER LUFTSCHIFFFAHRT.

Der Mangel aller bisher bestehenden aerologischen Methoden liegt in ihrer Beschränkung in der Auswahl der Momente und in einer gewissen Unbestimmtheit der Methoden selbst. Am geeignetsten wäre die Anwendung eines lenkbaren Luftschiffs, welches gestatten würde, eine beliebige Luftmasse in gewissen Zonen der Troposphäre zu erreichen und eine eingehende beliebig lange Untersuchung derselben mittelst genügend genauer Methoden und Instrumente auszuführen. Nur mit Hilfe eines Luftschiffes kann ein "fliegendes Laboratorium" geschaffen werden, das die Untersuchung der physischen und chemischen Eigenschaften der verschiedenen Luftschichten ermöglichen würde.

Ausserdem kann mit Hilfe eines Luftschiffs die Höhe der gewöhnlichen Sondierungen noch vergrössert werden, wenn auf der oberen Oberfläche des Schiffs Fesselballonaufstiege stattfinden. Wenn das Luftschiff dabei beständig die Geschwindigkeit des Luftstromes behält, in welchem sich der Ballon befindet, so wird der letztere immer vertikal über dem Luftschiff aufsteigen und kann so bei kleinem Verbrauch an Draht die Höhe der Stratosphäre oder noch Höher erreichen.*

3. STEIGGESCHWINDIGKEIT DER PILOTBALLONE IN DEN MORGENSTUNDEN IN ABHÄNGIGKEIT VON DEN WINDGESCHWINDIGKEITEN IN DER HÖHE VON 1000 M.

Die Bearbeitung der Doppelvisierungen in Pavlovsk hat gezeigt, dass die Steiggeschwindigkeit der Pilotballone von der Windgeschwindigkeit abhängt und dass folgende Formel des Zusammenhanges derselben mit der gleichzeitigen Windgeschwindigkeit in 1000 m. Höhe aufgestellt werden kann:

$$W = W_t (1 + 0.104 V^{\frac{1}{2}})$$

wo W — Steiggeschwindigkeit, W_t — theoretische Steiggeschwindigkeit, V — Windgeschwindigkeit in 1000m Höhe bedeuten.

Mit Hilfe dieser Formel können die Werte der Steiggeschwindigkeiten und der Windgeschwindigkeiten, die durch Einzelvisierungen erhalten sind, entsprechend verbessert werden. Die Abweichungen der Windgeschwindigkeiten in 500m und höher sind unbedeutend und erfordern daher keine Korrektur. Das Gesagte gilt nur für die Morgenstunden; in den Tagesstunden wird die Anbringung der Korrektur recht schwierig da um diese Zeit die Steiggeschwindigkeit nicht nur von der Stärke des Windes, sondern auch von einer Reihe anderer Faktoren abhängt.

* Prof. Dr. Hergesell hat schon im Jahre 1911 die Anwendung eines Luftschiffs als aeronautisches Observatorium vorgeschlagen, insbesondere die Methoden beschrieben, wie man von der oberen Plattform eines Luftschiffs Registrierballone auflassen und mit dem Luftschiff verfolgen kann. Die Geschwindigkeit des Luftschiffs würde in den meisten Fällen hinreichen, das Registrierballon-Paar in der Nähe der Vertikalen zu halten und den Landungsort aufzusuchen, ja vielleicht sogar den fallenden Ballon aufzufangen. (*Petermanns Mitteilungen* 1911, II, Heft 5, S. 245.)

4. APPARAT ZUR MESSUNG DER BÖIGKEIT DES WINDES IN DER FREIEN ATMOSPHERE.

Als Empfänger des Apparates dient ein Propeller mit Horizontalaxe und zwei dämpfenden Flächen. Die Axe des Propellers ist mit einer Feder verbunden, welche bei Beanspruchung ihren Widerstand so ändert, dass der Zusammenhang zwischen der Geschwindigkeit des auf den Propeller wirkenden Windes und der registrierten Ordinaten nahezu linear wird. Gleichzeitig mit der Registrierung der Windgeschwindigkeit wird auch die Summe bestimmter Stärken verzeichnet. Zu diesem Zweck ist auf der Axe des Propellers ein Zahnradchen mit schrägen Zähnen aufgesetzt, welches bei Drehung der Axe nur in einem Sinne mitgenommen wird, ähnlich wie bei dem Aufzugmechanismus der Uhren. Das Zahnrad bewegt mittelst einer mit ihm verbundenen schrägen Fläche einen mit der zweiten Feder verbundenen Hebel, wobei die Feder eine zickzackartige Registrierung erzeugt. Da die Drehung des Rädchen, den Abständen der Zähne gemäss, nur bei Böen bestimmter Stärke stattfinden kann, so giebt die Zahl der Zickzacks in einen Zeitintervalle ein Vorstellung von der Summe der Böen, welche eine bestimmte Grösse übersteigen.

APPENDIX IX.

Abstract of Papers communicated by Dr. W. Witkiewitch, Moscow.

(a) A NEW FORM OF SELF-RECORDING THEODOLITE.

This is a theodolite of the de Quervain type, provided with a view finder to facilitate following the balloon in the early stages of an ascent. The instrument is rendered self-recording by mounting it on a horizontal disc which can be rotated co-axially with a fixed vertical cylinder, which forms the main support of the instrument. The paper on which the record is traced is wrapped round this fixed cylinder. A rod depending vertically from the rotating horizontal disc carries the recording pen, which traces a horizontal line on the record sheet when the theodolite which traces a horizontal line on the record sheet when the theodolite is rotated in azimuth without change of inclination. The arrangement for recording variation of altitude is very simple. A disc is rigidly attached at right angles to the horizontal part of the theodolite telescope so that it rotates with it. A wire passing over the grooved circumference of this disc hangs down on the side of the instrument and is attached to the recording pen, so as to drag it up or down its vertical rod as the theodolite telescope is rotated for variation of altitude. The record of an ascent on the sheet is thus a curve of which azimuth and altitude are rectilinear coordinates.

In practice there are two recording pens and two records are traced, separated by a distance of a centimetre or two. Time marks are made on the curves by slightly moving the pens, the one horizontally the other vertically, at intervals of, say, one minute. The object of the two records is to ensure that the time marks shall always be easily identifiable on one or other of the traces. The time marks can, of course, be made by an electric chronograph, if desired.

The instrument may be used not only for pilot balloon work, but also for recording the variations in azimuth and angular altitude of clouds of the detached cumulus type. It is also suggested that it may be used conveniently for mapping the horizon of a meteorological station.

(b) ON THE MAXIMUM HEIGHT OF PILOT BALLOONS.

It is well known that considerable doubt attaches to many of the very high altitudes claimed to have been attained by pilot balloons, observed through one theodolite on the assumption of a constant ascensional

velocity. The assumption of a constant velocity is obviously not justified when holes develop in the fabric of the balloon through which the hydrogen can escape, but apart from that consideration, the balloon will float at a constant level if the ascensional force becomes zero, i.e., if the weight of the system becomes equal to the weight of air displaced. That will always occur at some limiting height, if the elastic pressure exerted by the envelope, which is equal to the difference between the pressure in the free air and the pressure of the imprisoned hydrogen, is taken into account. In order to throw further light on this question a series of experiments were undertaken to determine the difference between the external and the internal pressure in varying circumstances. It was found that when a balloon free from pinholes is being inflated, this pressure difference at first increases rapidly to a maximum, then decreases fairly rapidly to a minimum, and subsequently increases again slowly until the balloon bursts. The pilot balloons used in the Russian Service are of four types of diameter when unfilled—of 5, 10, 15, and 20 cm., the corresponding average weight being 7.6, 22.5, 33, 78.4 g.

Experiments on ten balloons of each type gave the following means:—

| Diameter unfilled. | At Maximum Pressure. | | At Minimum Pressure. | | | At Moment of Burst. | | |
|--------------------|----------------------|----------|----------------------|----------|-------------|---------------------|----------|-------------|
| | Press. Circum-Diff. | ference. | Press. Circum-Diff. | ference. | Thick-ness. | Press. Circum-Diff. | ference. | Thick-ness. |
| cm. | mm. | cm. | mm. | cm. | mm. | mm. | cm. | mm. |
| 5 | 48 | 22 | 14 | 77 | .031 | 19 | 108 | .016 |
| 10 | 20 | 44 | 5 | 174 | .020 | 6 | 199 | .016 |
| 15 | 16 | 55 | 4 | 202 | .022 | 5 | 233 | .016 |
| 20 | 11 | 87 | 3 | 304 | .025 | 4 | 380 | .016 |

Pressure differences are measured in millimetres of mercury.

It appears then that in the later stages of an ascent the elastic pressure of the envelope lies between 14 and 19 mm. of mercury for a 5 cm. balloon, between 5 and 6 mm. for a 10 cm. balloon, and between 4 and 5, and between 3 and 4 mm. for 15 cm. and 20 cm. balloons respectively. From these experimental results it is computed that equilibrium is reached for the various types of balloon at the following levels:—

| Envelope cm. | Height Limits in Kilometres. |
|--------------|------------------------------|
| 5 | 24-27 |
| 10 | 30-32 |
| 15 | 40-42 |
| 20 | 42-44 |

These values are of course limiting values, in practice such heights cannot be attained.

When making pilot balloon ascents the observer is called upon to use discretion in the selection of the size of balloon. Economy of hydrogen results in low ascensional velocities, which are impracticable on days of strong wind, as the balloon may vanish in the distance before it is lost in cloud. Again an estimate of the height of the cloud layer affords some guidance in the choice of balloon. The table opposite is put forward for the guidance of observers.

TABLE OF PERFORMANCES OF BALLOONS OF DIFFERENT SIZES.

| Height to be reached. | Diameter unfilled. | Circumference on Inflation. | Duration of Ascent. | Ascensional Velocity. | Volume. |
|-----------------------|--------------------|-----------------------------|---------------------|-----------------------|---------|
| km. | cm. | cm. | min. | m/min. | litre. |
| 2 | 5 | 100 | 20 | 98 | 17 |
| | 10 | 184 | 12 | 160 | 106 |
| 3 | 5 | 96 | 34 | 89 | 15 |
| | 10 | 176 | 20 | 152 | 93 |
| 4 | 5 | 94 | 47 | 85 | 14 |
| | 10 | 170 | 27 | 147 | 84 |
| 5 | 5 | 85 | 72 | 70 | 10.5 |
| | 10 | 155 | 38 | 132 | 63 |
| 6 | 10 | 149 | 49 | 122 | 56 |
| | 15 | 179 | 41 | 147 | 97 |
| 7 | 10 | 144 | 60 | 116 | 50 |
| | 15 | 172 | 50 | 140 | 86 |
| 8 | 20 | 272 | 32 | 220 | 343 |
| | 10 | 137 | 76 | 105 | 43.5 |
| 9 | 15 | 165 | 60 | 133 | 75 |
| | 20 | 260 | 37 | 215 | 299 |
| 10 | 10 | 132 | 95 | 95 | 39 |
| | 15 | 159 | 79 | 126 | 67 |
| 11 | 20 | 250 | 48 | 187 | 265 |
| | 10 | 128 | 122 | 82 | 35 |
| 12 | 15 | 152 | 86 | 116 | 60 |
| | 20 | 242 | 59 | 170 | 238 |
| 13 | 10 | 122 | 157 | 70 | 31 |
| | 15 | 147 | 100 | 110 | 53 |
| 14 | 20 | 232 | 70 | 156 | 211 |
| | 15 | 141 | 122 | 93 | 47 |
| 15 | 20 | 222 | 82 | 146 | 185 |
| | 15 | 135 | 167 | 81 | 41 |
| 16 | 20 | 213 | 100 | 136 | 163 |
| | 15 | 129 | 215 | 65 | 36 |
| 17 | 20 | 205 | 111 | 126 | 145 |
| | 20 | 196 | 129 | 116 | 127 |

APPENDIX X.

Choice of International Days.

Proposal by Dr. F. M. Exner.

Im November 1926 war lange Zeit hindurch der Luftdruck im Nord-westen Europas tief, im Südosten hoch, wobei über Mittel-Europa sehr warme Strömungen aus Süden lagen. Diese Druck- und Strömungsverteilung war schon am 12. November durch mehrere Tage vorhanden, trat dann am 17. November neuerdings auf und hielt über eine Woche lang an. Am 19. November war die Temperatur in Zentraleuropa schon so hoch gestiegen, die Depression zugleich (mit Minimalwerten nahe 730 mm.) bis nach

England eingedrungen, so dass man wohl erwarten sollte, die warme Strömung würde von einer kalten aus NW abgedrängt werden. Dies geschah nicht; am 21. November lag die Depression in kolossaler Grösse mit ihrem Zentrum am selben Ort wie am 19. November, bis 23. November rückte sie ein wenig ostwärts, aber die Südströmung hielt bis zum 23. November in der früheren Weise an.

Diese auffallende Andauer der starken Südströmung bei geringem Luftdruck über Zentraleuropa schien mir nur dadurch erklärbar zu sein, dass die Südströmung in sehr grosse Höhen hinaufreichte und dadurch die kälteren Stratosphärenmassen aus dem subtropischen Gebiet nach Europa brachte. Diesem Gedanken entsprechend veranlasste ich am 23. November 1926 einen Registrierballon-Aufstieg in Wien. Der Ballon stieg um 13h.31 auf und landete um 15h.27 im Nordosten von Wien (Slovakie) in 216 km. Entfernung. Er hatte zwischen 1,500m. Höhe beim Aufstieg und 1,880m. beim Abstieg eine durchschnittliche Geschwindigkeit von 33 m./sec. Die erreichte Höhe betrug 23 km. Es war also gewiss bis in sehr grosse Höhen hinauf ein intensiver SW-Wind.

Die Grenze zwischen Troposphäre und Stratosphäre wurde in etwa 12 km Höhe erreicht, die Temperatur betrug da -59° . In 16½ km Höhe begann ein neuerlicher Temperaturabfall, wobei das Minimum mit -63° in 17½ km. erreicht wurde. Die Temperatur stieg dann bis auf -57° in 21 km. Höhe und erreichte wieder -60° in 23 km.

Diese kurze Beschreibung dürfte genügen, um die folgende Auffassung erklärlich zu machen; *die grosse Depression über dem Nordwesten Europas wanderte aus dem Grunde durch lange Zeit nicht ostwärts, weil der Südstrom über Europa bis in sehr grosse Höhen hinaufreichte und die Zufuhr kalter Stratosphärenmasse aus dem Süden die Tendenz der Druckerniedrigung durch die Zufuhr warmer Troposphärenmasse aus dem Süden kompensierte.*

Dieser Fall erscheint mir für die weitere Ausbildung unserer meteorologischen Kenntnisse ein nützliches Beispiel. Ich möchte mir daher erlauben, den Wunsch auszusprechen, dass in Zukunft die internationalen Aufstiege über Europa der Mehrzahl nach für bestimmte, besondere Wetterlagen benützt werden sollen. Hiefür wäre es nötig, dass die Institute ihr Aufstiegsinstrumentarium vollständig in Vorbereitung haben und durch telegraphische Nachricht seitens des Präsidenten der Kommission für solche Aufstiege verständigt werden.

APPENDIX XI.

Résolutions de la réunion de Leipzig.

I. La Commission recommande d'envoyer chaque mois au Président les données sur l'heure et la date de tous les sondages aérologiques, contenant des observations de température afin que le Président puisse adresser, chaque mois, aux intéressés une liste de l'ensemble des observations aérologiques disponibles.

A côté du rapport mensuel sur les résultats des ascensions on demande d'envoyer immédiatement après la fin d'un mois au président la liste des entreprises aérologiques qui ont eu lieu aux jours internationaux de ce mois.

II. A propos de résolution LXV du Comité international météorologique à Vienne, la Commission exprime le vœu de voir réunir le plutôt possible les observations de ballons-pilotes à la Russie, la France, l'Allemagne, l'Angleterre et le Belgique et que cela soit fait conformément au programme adressé précédemment par M. Exner, car on a l'intention de procéder à une étude de toutes les observations selon un plan unique.

III. La Commission approuve que le Bureau ferait circuler un exemplaire du volume spécimen aux directeurs des réseaux qui sont inclus dans la liste du bureau du comité météorologique international ceux-ci n'étant pas aussi membres de la Commission.

IV. Tout vice-président doit rassembler les données de sa propre région et envoyer un seul exemplaire au Président qui, lui-même, réunira les diverses parties dans un volume unique.

V. Les observations de la haute atmosphère aux jours internationaux sont publiées d'un façon internationale par le Président de la Commission. Pour couvrir les frais d'impression chaque pays co-opérant aux travaux de l'investigation de la haute atmosphère ou s'intéressant à ces travaux est instamment prié soit de mettre à la disposition du Président une somme annuelle fixe, soit d'acheter un nombre fixe d'exemplaires à un prix à fixer chaque fois par le Président.

Ce prix doit être calculé de façon qu'après la vente de tous les exemplaires disponibles les frais sont couvertes complètement.

Les pays qui mettent à disposition du Président une somme fixe pourront recevoir un nombre d'exemplaires calculé d'après le prix d'un exemplaire.

VI. Qu'un appel signé par le Président, par les anciens Présidents de la Commission et par le Président du Comité météorologique international soit envoyé aux directeurs de réseaux leur demandant une contribution aux fonds nécessaires pour la réalisation des désirs exprimés dans les résolutions.

VII. Que l'attention des météorologistes soit attirée sur la transcription des hauteurs dans les diverses opérations météorologiques, afin de préciser 1° dans quelles mesures les hauteurs transcrites sont orthométriques ou sont effectivement des hauteurs géopotentielles converties en métriques au moyen d'une valeur conventionnelle de la pesanteur, et 2° les modifications aux méthodes en usage qui seraient nécessaires pour établir un système général (unifié) faisant usage du géopotential au lieu de la hauteur comme coordonnée verticale.

VIII. La Commission étant d'avis que l'exécution simultanée d'ascensions aérologiques et d'enregistrements de la radiation solaire et atmosphérique aurait d'intérêt pour l'élucidation des phénomènes de l'atmosphère, désire vivement voir poursuivre les recherches à ces fins.

IX. La Commission pour l'Exploration de la haute Atmosphère estime grandement utile d'instituer des ascensions de ballons-sondes et des mesures de propagation de son d'après les méthodes décrits par Lindenberg et par M. Whipple, aux latitudes élevées et aux latitudes basses afin de recevoir des indications sur la température aux très grandes hauteurs.

X. La Commission recommande l'emploi de ballons dirigeables munis d'une plateforme supérieure afin de permettre des ascensions de ballons sondes et de ballons-captifs. Les ballons sondes, grâce à la vitesse du dirigéable, peuvent être aisément suivis et retrouvés. Le ballon captif restant à la verticale du dirigéable, pourrait atteindre les couches de la stratosphère.

Cette méthode est particulièrement indiquée pour les régions polaires et désertiques.

XI. La Commission approuve les décisions suivantes: Que dans la publication internationale, l'Avant Propos et les légendes des signes conventionnels ainsi que la traduction des abréviations employées dans les tableaux et dans les cartes synoptiques soient rédigés à l'avenir en deux langues au moins.

XII. Que, conformément à la proposition de la délégation française, M. le docteur Hergesell soit nommé président de la Commission pour succéder à Sir Napier Shaw, dont la décision de démissionner est apprise avec regret.

XIII. Que M. le Dr. C. W. B. Normand qui a succédé à Mr. J. H. Field comme Director-General of Indian Observatories soit élu vice-président de la Région D.

XIV. Que le Président soit laissé libre de placer en dehors du mois international les six ascensions à la discrétion du président et d'apporter aux groupes des jours choisis les modifications légères qu'il pourra juger utiles.

XV. Que Sir Napier Shaw soit nommé Président d'honneur afin de rendre hommage aux services éminents qu'il a rendu à la science météorologique et à notre Commission durant sa présidence.

XVI. Que la Commission donne son approbation au volume spécimen pour 1923, sous réserve des légères modifications proposées dans les rapports des diverses Sous-Commissions.

XVII. Qu'il est à désirer que le volume pour 1924 soit rédigé sous la même forme que celui pour 1923, ou sous une forme très peu différent. Le Bureau décidera de ce qui sera fait pour les années suivantes dès que le rapport de la Sous-Commission des tableaux aura été présenté.

RÉSOLUTIONS À PROPOS DE LA PUBLICATION INTERNATIONALE EN PROJET.

XVIII. *Ière Partie, Avant-Propos.*—1. Les coordonnées à employer sont la longitude géographique, la latitude géographique, et le géopotential.

2. Les unités à employer dans les fiches et dans les publications de la Commission sont les suivantes :

Latitude en degrés et minutes.

Longitude en degrés et minutes, comptée à partir du méridien de Greenwich.

Géopotential en mètres dynamiques au dessus du niveau de la mer.

Heure, T. M. G.

Longueurs en mètres.

Pression barométrique en millibares.

Température en degrés absolus ($273^{\circ} + C.$) et dixièmes.

Température potentielle en degrés et dixièmes, rapportée à une pression de 1000 mb.

Chute verticale de la température, en degrés et dixièmes pour différences d'altitude de 100 mètres dynamiques.

Humidité : humidité relative pour cent.

Direction du vent, soit en degrés à partir du nord, ou d'après l'échelle 01—36, d'après laquelle 36 représente un vent de nord et 09 un vent d'est.

Vitesse du vent en mètres par seconde.

Nuages d'après l'échelle internationale.

Direction du mouvement des nuages d'après l'échelle 01—36.

Vitesse angulaire du mouvement des nuages en unités 1000 V/H',

V étant la vitesse en mètres par seconde et H', l'altitude en mètres.

Nébulosité d'après l'échelle 0—10, séparément pour les nuages de chaque nature.

Poids des ballons en grammes.

Force ascensionnelle des ballons en grammes.

Diamètre des ballons (gonflés) en centimètres.

3. Les ascensions seront exécutées autant que possible à une ou plusieurs des heures suivantes : 01, 07, 13, 19, T.M.G.

4. La pression et la température, et, si possible l'humidité, seront donnés (1°) pour tous les géopotentials pour lesquels il se trouve des variations considérables de la chute verticale, 2°) pour les pressions normales de 1000, 900 100 mb., et 3°) pour les géopotentials normaux de 500, 1000, 1500, 2000, 3000 mètres géodynamiques.

5. Une indication du vent sera donnée pour la station et pour les couches de géopotential avec un vent à peu près homogène.

6. La Sous Commission est d'avis que les tableaux des valeurs numériques constituent la partie la plus importante de la publication, ensuite les téphigrammes et en dernier lieu les cartes des pressions.

7. Il ne faudrait pas que les données de l'altitude soient entièrement omises dans la publication. Le système d'après lequel ces données devraient être insérées sera étudié par la sous-commission qui étudiera aussi les tableaux.

XIX. *II ème Partie, Cartes synoptiques.*—1. Que l'attention de ceux qui à l'avenir seront chargés de la rédaction des cartes en question soit attirée sur l'avantage qu'il y aurait à utiliser pour le traçage des isobares un système d'unités—millibares ou millimètres—uniforme pour tout le globe terrestre.

2. La Sous-Commission prit note de la discontinuité du temps. Elle fait appel au Comité météorologique international et à la Commission des renseignements synoptiques, leur demandant de tenir compte des desiderata de la Commission de la haute atmosphère et de faire tous les efforts possibles pour assurer l'uniformité du temps.

La Sous-Commission a examiné avec intérêt le projet de carte présenté par M. Cahill. Elle estime cependant qu'une résolution pour décider de l'adoption de cette méthode dans les travaux de la commission ne saurait être présentée avant une étude plus approfondie de l'adaptation de la méthode à la rédaction des cartes météorologiques.*

3. La liste des données doit être maintenue ; éventuellement on pourrait la faire passer à la partie consacrée aux tableaux.

* La question de l'échelle et de la projection pour les cartes météorologiques à adopter universellement fut discutée à la réunion du Comité international tenue à Londres en 1921 (voir résolution 34).

XX. *III ème Partie. Tableaux.*—Q'une petite sous-commission constituée par M. le président avec M.M. Exner, Gamba, Lempfert, Canne-gieter, et Hesselberg, soit formée pour déterminer le meilleur plan d'ensemble de l'ouvrage et des fiches.

Le rapport de la sous-commission sera soumis aux vice-présidents.

XXI. *IV ème Partie. Téphigrammes.*—La sous-commission est d'avis qu'à l'avenir les téphigrammes devraient être donnés dans la publication internationale sous forme d'annexes aux tableaux des valeurs numériques dans la mesure où les fonds le permettront.

XXII. La Commission désire exprimer sa profonde obligation pour les préparations excellentes faites par M. le Prof. Weickmann pour la réunion de la Commission et pour toute la cordialité du personnel de son Institut. Elle exprime aussi ses remerciements les plus profonds au comité de la Foire de Leipsic pour les préparations admirables faites pour accommoder les membres de cette Commission pendant la semaine de la réunion quand de demandes lourdes de la Foire devaient être satisfaites. En continuation, la Commission exprime son grand appréciation pour la réception faite par le Gouvernement de Saxe, le Gouvernement du Reich, l'Université et la Ville de Leipsic.

La Commission considère avec reconnaissance la nature cordiale de toutes ses procédés comme une anticipation la plus profonde pour ces amabilités, que la Commission espère avec confiance qu'elles seront exprimées plus fondamentalement par l'influence que la réunion aura sur le développement de l'étude de la haute atmosphère.

APPENDIX XII.

List of Members of the Commission, Leipzig, 3rd September, 1927.

Bureau.

- Prof. Dr. H. Hergesell, Preussisches Aeronautisches Observatorium, Lindenberg, Kreis Beeskow, Germany. (*President.*)
 Dr. Th. Hesselberg, Det Norske Meteorologiske Institutt, Oslo, Norway (*Secretary.*)
 Mr. R. G. K. Lempfert, Meteorological Office, Air Ministry, Kingsway, London, W.C.2. (*Secretary.*)

Members.

- Mons. le Commandant José Agostinho, Director of the Meteorological Service of the Azores, Ponta Delgada, Azores.
 Prof. F. Akerblom, Meteorologiska Observatorium, Upsala, Sweden.
 Prof. Dr. E. Alt, Direktor der Sächsischen Landeswetterwarte, Dresden.
 Dr. H. Arctowski, Director of the Geophysical Institute, University of Lwow, Poland.
 M. le Capitaine José Machado de Barros.
 Dr. W. van Bemmelen, The University, Amsterdam, Holland.
 Prof. V. Bjerknes, Physical Institute of the University, Oslo, Norway.
 Dr. J. Boerema, K. Magnetisch en Meteorologisch Observatorium, Batavia, Java, Dutch East Indies.
 Dr. H. G. Cannegieter, Koninklijk Nederlandsch Meteorologisch Instituut, de Bilt, Holland.
 Capt. C. J. P. Cave, Stoner Hill, Petersfield, Hants.
 Mr. T. F. Claxton, Director, Royal Observatory, Hong Kong, China.
 Dr. D. la Cour, Det Danske Meteorologiske Institut, Copenhagen, Denmark.
 M. le Général E. Delcambre, Directeur, Office National Météorologique, rue de l'Université, 176, Paris, France.
 Mr. L. H. G. Dines, Kew Observatory (Upper Air Section), Old Deer Park, Richmond, Surrey.
 Mr. W. H. Dines,* Benson Observatory, Wallingford, Berks.
 Mons. R. Dongier, Institut de Physique du Globe de la Faculté des Sciences de l'Université de Paris, rue de St. Jacques, 191, Paris, France.
 Prof. F. Eredia, Il Capo, Ufficio Presagi, Ministero dell' Aeronautica, via del Caravita, 7a, Rome, Italy.
 Prof. Dr. E. van Everdingen, Koninklijk Nederlandsch Meteorologisch Instituut, de Bilt, Holland.
 Prof. Dr. F. M. Exner, Direktor der Centralanstalt für Meteorologie und Geodynamik, Hohe Warte, 38, Wien XIX, Austria.
 Dr. Sampaio Ferraz, Directoria de Meteorologia, Palacio dos Estados, 4 andar, Rio de Janeiro, Brazil.
 Dr. E. Fontseré, Jefe, Servei Meteorologic da Catalunya, Urgell, 187, Barcelona, Spain.
 Dr. S. Fujiwhara, Central Meteorological Observatory, Tokyo, Japan.
 Prof. P. Gamba, R. Osservatorio Geofisico, Pavia, Italy.
 Prof. Dr. W. Georgii, Mauerweg 32, Frankfurt am Main, Germany.

* Mr. Dines died 24th December, 1927.

- Lieut.-Col. E. Gold, Meteorological Office, Air Ministry, Adastral House, Kingsway, London, W.C.2.
 Mr. W. R. Gregg, Chief of the Aerological Division, U.S. Weather Bureau, Washington, D.C., U.S.A.
 Prof. Dr. B. Helland Hansen, Geofysisk Institut, Bergen, Norway.
 Mr. H. A. Hunt, Commonwealth Meteorologist, Commonwealth Meteorological Bureau, Melbourne, Australia.
 Mons. P. Idrac, Charge des études de la haute atmosphère, Office National Météorologique, rue de l'Université, 176, Paris, France.
 Commandant J. Jaumotte, Institut Royal Météorologique de Belgique, Uccle, Belgium.
 Dr. K. Keil, Preussisches Aeronautisches Observatorium, Lindenberg, Germany.
 Dr. E. Kidson, Director, Dominion Meteorological Office, Wellington, New Zealand.
 Prof. Dr. F. Linke, Direktor, Meteorologisch-Geophysikalisches Institut der Universität, Frankfurt a/Main, Germany.
 Dr. G. Marcell, in charge of aerological work, M. Kir Orszagos Meteorologiai es Foldmagnesegi Intezet, Budapest, Hungary.
 Dr. E. G. Mariolopoulos, Chief of the Meteorological Section, Observatoire National, Athens, Greece.
 Dr. C. F. Marvin, Chief, U.S. Weather Bureau, Washington, D.C., U.S.A. (*Vice-President of Region A.*)
 Lieut. Col. L. Matteuzzi, Servizio aerologico, Vigna di Valle, Roma, Italy.
 Mons. Ch. Maurain, Directeur, Institut de Physique du Globe de l'Université, rue de Sainte-Jacques 191, Paris, France.
 Prof. A. McAdie, Blue Hill Observatory, Readville, Mass., U.S.A.
 Col. E. Meseguer, Jefe, Servicio Meteorologico Español, Madrid, Spain.
 Prof. P. Molchanoff, Aerological Observatory, Slutzk (Pavlovsk), U.S.S.R.
 Mons. Chr. A. C. Nell, Société Aérologique, De Perponcherstraat, 49, The Hague, Holland.
 Dr. C. W. B. Normand, Director-General of Indian Observatories, India Meteorological Department, Simla, India. (*Vice-President of Region D.*)
 Dr. W. Oishi, Director, Aerological Observatory, Tateno, Ibaraki ken, Japan.
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 Mr. J. Patterson, Meteorological Office, Toronto, Ontario, Canada.
 Prof. Dr. A. Peppler, Direktor der Badischen Landeswetterwarte, Karlsruhe, Germany.
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 Dr. L. F. Richardson, Westminster Training College, Horseferry Road, London, S.W.1.
 Rev. Father Rodés, S.J., Director of the Observatorio del Ebro, Tortosa, Spain.
 Dr. S. Róna, Director, M. Kir. Orszagos Meteorologiai es Foldmagnesegi Intezet, Budapest, Hungary.
 Mons. E. Rothé, Institut de Physique du Globe, Université de Strasbourg, 38 Boulevard d'Anvers, Strasbourg, Alsace-Lorraine.
 Dr. J. W. Sandström, Statens Meteorologisk-Hydrografiska Anstalt, Stockholm, Sweden.
 Mons. Ph. Schereschewsky, 11, Eisenbahnstrasse, Sarrebruck, Sarre.
 Prof. Dr. A. Schmauss, Direktor, Bayerische Landeswetterwarte, München, Germany.

- Mr. R. Sekiguchi, Imperial Marine Observatory, Kobe, Japan.
 Sir Napier Shaw, 10, Moreton Gardens, London, S.W.5. (*Honorary President*).
 Mr. C. Stewart, Chief Meteorologist, Department of Irrigation, P.O. Box 399, Pretoria, South Africa.
 Dr. Griffith Taylor, Professor of Geography. University of Sydney, New South Wales, Australia.
 Prof. G. I. Taylor, Trinity College, Cambridge, England.
 Mr. Andrew Thomson, Director, The Observatory, Apia, Samoa.
 Sir Gilbert Walker, Professor of Meteorology, Imperial College of Science and Technology, South Kensington, London, S.W.7.
 Dr. A. Wallén, Statens Meteorologisk-Hydrografiska Anstalt, Stockholm, Sweden.
 Mons. le Capitaine P. Wehrlé, Office National Météorologique, rue de l'Université, 176, Paris, France.
 Prof. Dr. L. Weickmann, Direktor des Geophysikalischen Instituts der Universität, Talstr. 38, Leipzig, Germany.
 Dr. P. Zistler, Bayerische Landeswetterwarte, München, Germany.

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